POWER

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Force—Energy—Work—Power

THESE four terms are often confused, especially in popular usage.

Every pound of water in a pond a thousand feet above the sea level has in it a thousand foot-pounds of potential Energy.

A pound of good coal has in it something like ten million foot-pounds of potential Energy.

A pound weight moving at the velocity of the earth at the equator has in it over thirty-six thousand foot-pounds of kinetic Energy.

When the water falls, the Force of the attraction between it and the earth does Work upon it. If it falls freely, this Work is expended in overcoming its inertia and accelerating its motion. The potential Energy of position has been converted to the kinetic Energy of motion.

If it goes through a turbine, its velocity is reduced to only that necessary to let it get out of the way. The remaining velocity is reconverted to Force in its pressure upon the vanes of the turbine, and the product of that Force and the movement which it induces in the turbine is Work.

A quantity of water discharged through a large turbine in an hour will generate just as many and no more foot-pounds of Energy as would the same quantity discharged through a smaller turbine of equal efficiency under the same head in ten hours, but the Power of the larger turbine will be ten times that of the smaller. Power is Work divided by time. The shorter the time used in the generation or application of a given number of foot-pounds of Energy, the Greater the Power.

A man may be full of Energy but not do much Work, but he is a Power if he can apply a lot of Force in a limited time.

F. R. Low

Maintenance of Wood-Stave Pipe in Hydro-Electric Practice

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CONTINUOUS wood-stave pipe for water-power conduits is manufactured in all sizes from 2 to 14 ft. or more internal diameter. This type of pipe is particularly adapted to the construction of lines in rough, mountainous or relatively inaccessible places because of its subdivision into a large number of comparatively light parts, capable of being handled by pack animals or by men. The tools and equipment required for erection are simple and also easily portable. Great speed in construction is attainable and the cost of construction is therefore comparatively low.

On account of the range of sizes obtainable, it can be adapted to nearly all the practical requirements for pressure pipes within its limits. The practical limit of static head for a wood-stave pipe, say of 12-ft. diameter, is about 250 ft. For smaller sizes, this limit, of course, increases.

Wood-stave pipe has also been utilized for conducting condensing water from steam turbines. Care must be taken to protect such installations against the collapsing effects of possible vacuums, or else such vacuums must be effectually eliminated. Such protection may take the form of a concrete jacket poured around the pipe, with or without reinforcement.

Where wood pipe is expected to sustain a vacuum the staves are sometimes made extra thick and provided with a heavy tongue and groove in the edges. A special malleable-iron butt joint is also advisable instead of the plain steel clip in the end joints between staves.

Experiments show that the coefficient of friction for wood-stave pipe in the Hazen-Williams formula, after long use is about 120 as compared to 110 or even 100 for old steel and cast-iron pipe. After being put in service a slime forms on the interior surface which is exceedingly slippery, and which apparently does not reduce the friction coefficient in the above mentioned formula.

Wire-wound or machine-made wood-stave pipe is made in all sizes from about 3 to 42 in. internal diameter. On account of the smallness of such pipe, it is infrequently used in hydro-electric pressure lines except in small plants.

An objection frequently raised to wood-stave pipes is that their durability or life is short or uncertain. It is found that many of the examples cited in proof of such assertions were laid in such a manner or under such conditions that short life or other troubles must have inevitably resulted.

There are many examples of untreated pipes which have lasted from 20 to 30 years and upward, under favorable conditions. There are many other examples of pipes which have shown signs of decay at a very early age.

It is the opinion of the writer and of many other engineers who have had experience, that to obtain the maximum life under low and medium heads, it is preferable to install the pipe entirely above ground and to give the staves some sort of treatment, at least on the exterior.

Contact with wood-stave pipes over a considerable number of years, coupled with the opinions of other engineers who have had varying experiences with pipes of this material leads to the thought that many of the unfavorable results have sprung from failure to fully appreciate the character and limitations of the materials where used for this purpose. There are certain fundamental features of design, construction, workmanship, character of materials and of maintenance which directly affect the life of wood pipes. A careful analysis will usually show that many failures were due to negiect of one or more of these fundamentals.

THE use of wood-stave pipe for water-power conduits has increased greatly in the last few years. That difficulties have been experienced in operation is quite evident from the number of inquiries received by the author for information relative to the proper methods of installation and maintenance. As a result of these inquiries it has seemed proper to gather together and publish the available information, including description of a number of cases where troubles with wood-stave pipe have developed in and near New York State which, together with a knowledge of the means taken to safeguard the pipe and lengthen its life, have come to the attention of the writer. This article and a subsequent one are devoted to a discussion of these cases and a description of what appears to be suitable methods of installing and maintaining such pipe so as to obtain the longest life.

A pipe line of any material and of any appreciable length represents a substantial investment. It therefore follows that all reasonable precautions should be taken to insure its satisfactory operation and increase its useful life. Poor maintenance can defeat the result aimed at by the most careful design and construction.

The life of wood-stave pipe is affected largely by the manner in which it is laid. Wood pipe is commonly laid in a trench and completely backfilled. By some it is laid in a trench and partially backfilled, while others prefer to lay it in cradles entirely above ground as in the figure. The latter has the advantage that the pipe can be inspected at all times and its condition determined. Any leaks which may appear are visible and can be quickly and easily repaired.

A number of varieties of timber have been used with greater or less success. The most usual varieties at this time are Douglas fir and redwood, which are produced extensively on the Pacific Coast. Longleaf yellow pine has been used with success, and to a limited extent, cypress. The latter two species require more care in the selection of first-class timber for construction and are not as generally used.

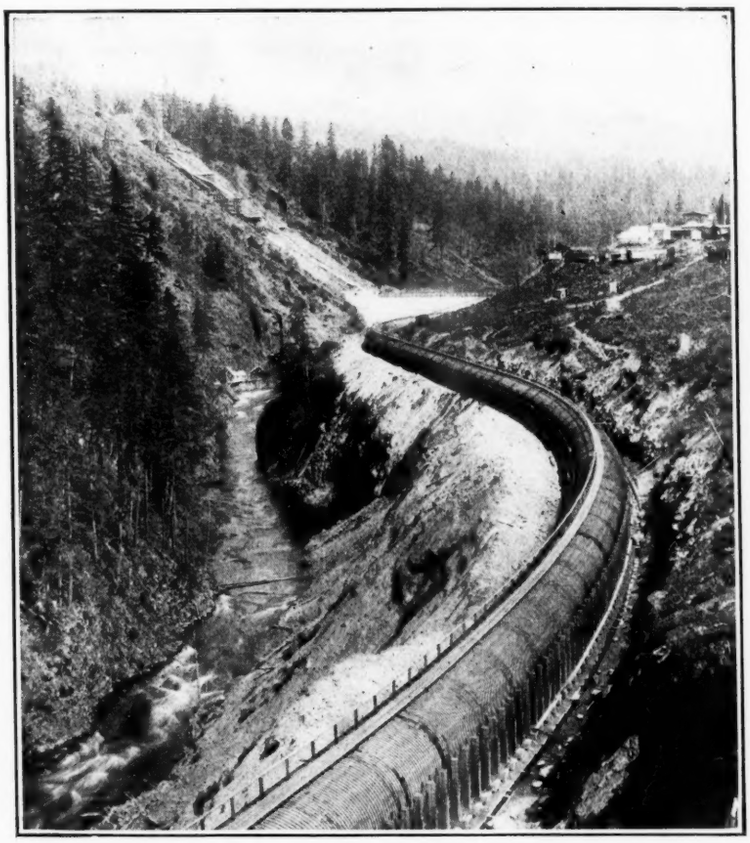
In the construction of wood-stave pipe only first-

class timber should be used. Hence, it is necessary that practically no sap wood be allowed, particularly on the outside. For the longest life, all sap wood should be excluded. It is also necessary that there should be no knots, shakes, checks or other imperfections. The reason for this is apparent when it is recalled that the timber used in pipes is expected to stand for from 20 years upward, exposed to the earth or to all kinds of weather, with alternate wetting and drying.

The interior of the pipe suffers very little deterioration, being constantly saturated with the water with which it is filled, unless the pipe should be used intermittently and emptied when not in use. If the pipe is allowed to remain empty for periods of any considerable length, sufficient to allow it to dry out, its life will be much reduced.

The amount of static head in the pipe ordinarily has a material influence on the life of wood pipe. Where this head is great enough to force the water entirely through to the outside of a pipe laid underground so as to keep it always wet, and the soil condition is favorable to preservation of the pipe, this may be the best way to lay wood pipe.

Staves treated by the pressure vacuum creosoting process, while not pleasant to handle, appear to insure satisfactory life several years in excess of untreated staves. Untreated pipes laid above ground soon start to deteriorate. This has in some instances been arrested by applying light creosote oil to the outside, while the pipe was in service. It is necessary, of course, to carefully cinch up the pipe and stop all leaks so that the exterior surface will be in a dry condition ready to absorb the treatment.



Wood-stave pipe supported in cradles above ground

The treatment adopted in these cases was to apply two coats of light creosote oil as hot as possible. This coating will have a life of several years before requiring additional treatment. It has also been suggested that in applying this treatment, the bands and staves should be painted with an asphaltum or tar-base black paint, after applying the creosote oil, which would prevent the lighter creosote oils from evaporating, which they would otherwise do if not protected. It would then seem to be necessary only to renew the outer coating, which being a durable paint, would need to be done only at intervals of several years.

This suggests that a feasible means of treating new pipes laid in the open would be to build them out of untreated staves and then apply two coats of hot creosote oil on the outside before filling with water, and after the pipe has been cinched up and made tight, to apply the tar or asphaltum paint.

The particular advantage of this latter method, over the pressure-vacuum creosoting process, is that the interior surface of the pipe and the edges of the staves will be practically unaffected by the oil and in a condition to absorb water readily and tighten up easily and quickly when first filled. This is not a very material advantage, however, as pipes creosoted with the lighter grade of oil will still absorb some water, swell and close the joints, though not as readily as the untreated lumber. Experiments made on the strength of fir staves creosoted by the boiling or high-temperature system have shown a loss of mechanical strength of as much as 30 per cent. The same timber treated by the vacuum or low-temperature process showed no appreciable loss of strength.

A résumé of the experience of the United States Reclamation Service, published some years ago, states that untreated redwood or fir pipes buried in tight soil have a much longer life than those buried in loose, porous soil. A pipe which is continuously saturated has a much longer life than one undergoing changes in the degree of saturation.

Decay usually starts at the ends of the staves or at spots where the wood has been bruised, and particularly in any sap wood which may be exposed on the outside of the pipe.

In several cases where buried pipes have started to decay, the decay has been arrested by removing the earth, leaving the pipe uncovered. In such cases it is probable that the cover contained vegetable mold and was more or less porous.

Ordinary paints have been applied to wood pipes in many cases, but in general have been found to be of little assistance in preventing decay. It is apparent that a coating or treatment applied for this purpose should contain phenols or other substances which inhibit the growth of fungi and that such treatment must be renewed from time to time when its effectiveness has been dissipated.

Deterioration always occurs on the exterior of the pipe and hence, the outer surface is the one which requires protection. With the application of exterior treatment at reasonable intervals, the maximum life of

the pipe will be lengthened to an extent which cannot be predicted. If proper inspection is made and treatment renewed whenever required, it seems probable that wood pipe will have a life at least equal to riveted steel pipe.

The disadvantage of laying the pipe in the open is the tendency for the pipe to check and decay, especially the upper half. Treatment with creosote minimizes this condition and prolongs the life of the wood.

Locating Leaks in Pipes Laid Underground

Where pipe is laid partially or entirely underground, it is difficult at times to determine the origin of leaks. The writer has known of cases where it was necessary to excavate for distances of 100 ft. and more along a pipe in order to locate leaks and this is sometimes a serious disadvantage, especially in soils and situations where it is possible for much washing to take place. Laying in this manner also has a serious disadvantage in alkali soils and various other soils which tend to cause delay or disintegration in the wood or steel. On the whole, it seems advisable to lay such pipe entirely above ground unless conditions are favorable to its preservation underground.

A case in point is that of a large wood-stave pipe laid on a flat gradient, with low static head, in a trench and completely backfilled with fine sand. After some five years, the pipe was examined and it was found that much decay had taken place in the staves above the horizontal center line, particularly at the top.

It was concluded, after careful investigation, that this condition was caused by the lack of sufficient static head to force enough water through the staves to keep it sufficiently wet in the exterior, coupled with the presence of certain fungi, in the backfill material. Where the backfill was found to be sterile or oxygen could not be supplied in sufficient quantities to promote the growth of fungi, this trouble did not exist. The portions infested consisted of more or less of the top soil originally removed when making the excavation. Care should therefore be taken to exclude such material from contact with a buried pipe. Creosoting the wood undoubtedly would have greatly minimized the difficulty.

Repairing a Decayed Pipe Line

The remedy applied was to remove the backfill down to the horizontal center line, scrape off the decayed portions, and fill with cement plaster the space under the bands formerly occupied by the decayed wood. A few strands of No. 9 steel firm wire were embedded in the plaster as reinforcement. In this case, no doubt, much better results would have been obtained had the pipe been laid above ground on cradles.

In the construction of a section of wood-stave pipe it is necessary, particularly in dry weather, to go over it at frequent intervals and again cinch up the bands, as the wood dries out rapidly and the pipe would fall apart unless this were done.

Under dry weather conditions, when the pipe is first filled, a large number of leaks will naturally appear. It is customary to fill these pipes slowly so as to minimize this leakage and allow the wood to soak up water, which it does rapidly, bringing the staves into contact, thus closing the greater part of the leaks. Such leaks as remain after a few hours have to be eliminated by cinching up the bands in the vicinity of the leaks, and in some cases by wedging. This is done by driving in a chisel a half inch or thereabouts from the edge of the stave and then driving a thin soft-pine wedge into the check so formed. This wedges the edges of the staves tightly together. Occasionally, small holes will be found which it is necessary to close by means of small pine plugs.

The ends of the staves are customarily made tight against leakage by a saw cut across the end of each abutting stave into which is slipped a thin sheet-steel clip about 1½ or 2 in. long, the length of which, across the stave, is slightly greater than the width of the individual staves so that it cuts into the adjoining staves on each side. These clips should be either galvanized with first-class spelter or painted, to avoid corrosion.

A recent improvement for this purpose is in the form of a galvanized malleable-iron casting having a thin web which fits between the ends of adjacent staves. A thin fin, corresponding to the clip, projects from this web at its center, of such a size as to cut into the ends of the adjacent staves as well as slightly into the staves on either side. Flanges are cast at top and bottom which completely cover the space between the ends of the staves and project slightly over the staves at both sides and ends of the joint. This construction greatly assists in holding the staves in their proper positions at each joint. It was designed especially for use in cases where vacuums are expected.

Repairing Leaks in Wood-Stave Pipe

A number of cases of bad leaks in old continuous wood pipe lines have come under the writer's observation. Where these leaks are slight and the wood is in good condition, they can be repaired by driving in a chisel near the edge of the stave and wedging up with soft pine wedges as described above. When these leaks become serious and cannot be so repaired, the writer has seen a number of repairs made by loosening up several bands and placing underneath them a section of thin steel plate of about No. 10 gage or thicker, rolled to the radius of the circumference of the pipe and placed over the leak inside the bands, after which the bands were tightened up. This is an effective method and will prolong the usefulness of a pipe which is bad in spots of not too great dimensions. While it may at times be impossible by this means to eliminate all leakage, this method has the advantage of greatly reducing the outflow, permitting the pipe to go back into service for a considerable time without extensive repairs or rebuilding. It is sometimes necessary to caulk under the edges of such plates as well as to wedge up and close leaky seams which may be found to extend beyond the plate after refilling the pipe with water and full pressure has been established.

When a pipe has reached the stage of serious leaks at many points, the wood is often in such a condition throughout the pipe that it would be dangerous on account of the possibility of collapse, to allow the pipe to remain empty while making repairs or partially rebuilding for a long enough time to permit it to dry out to any great extent. A further trouble is that when such a pipe is refilled, after so drying out, new leaks invariably appear and require some time to close up.

A repair made in the manner outlined in the foregoing can be completed within a short time, thus keeping an important pipe out of use for only a few hours at the most and minimizing the troubles which follow when the pipe is refilled.

Maintenance of Oil Circuit Breakers—Contacts and Oil

Inspection and Adjustment of Different Types of Contacts—Care of Connections and Bushings—Cautions to Observe When Removing and Replacing the Oil Tanks—Sampling and Testing Oil to Determine Its Insulation Qualities

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AS THE oil circuit breaker is designed to open or close an electric circuit, the mechanical construction and the adjustment of the parts directly concerned in these operations are very important.

Contacts—The designer of the breaker sees that the contact area of the movable and fixed contacts is sufficient to allow a current flow equal to the equipment's current-carrying capacity without injurious heating, provided the contact areas are properly adjusted to make good contact with each other. If the contacts are not adjusted correctly, the resistance to the passage of an electric current across the contact surfaces will cause these parts to become heated to a high temperature, melting the solder which may be used in the breaker assembly and for fastening connecting leads to their terminals, and thereby reducing the device's efficiency of operation as a whole. Excessive heating may soften the copper contacts and contact springs so that the spring action of the contacts is impaired and poor contact is the result.

The contacts must be kept clean and free from grit or dirt. At the regular inspection intervals clean the contacts and then swab a thin coat of vaseline over their surface. This will prevent undue wear by lessening the tendency for the contact areas to grab and dig into each other in closing or opening.

The contact alignment should be carefully checked, as misalignment will reduce the contact area. Examine the supports to make sure that the contacts are properly held or fastened to them. Contact surfaces that have been pitted or burned in actual service should be smoothed down with a fine file or emery cloth. If too badly burned to allow of redressing, the contacts should be replaced. The following are examples of various kinds of contacts and their detail adjustments:

Finger-Type Contacts Without Arcing Tips

The contacts illustrated in Fig. 1 are of the well-known finger variety, having two breaks per pole, or per phase. Contact for each phase is made between either end of a movable copper blade, fastened at its middle to the operating rod through a pin connection, and two stationary spring contact clips mounted on the lower ends of their respective bushings, or insulators. In closing, the movable blade contact enters between the edges of the clips, spreading them slightly. On opening, the final break of the arc takes place between the top edge of the movable blade and the ends of the stationary clip contacts.

Adjustment of the contact surfaces may be done by bending the contact clips slightly until satisfactory contact is secured.

In Figs. 2 to 4 is shown a different type of finger contact in the closed, breaking and open position. The movable blade for each phase is wedge-shaped and is clamped to its operating rod. Each of the two stationary fixed contacts consists of copper segments reinforced by steel spring fingers and the whole secured to a support which is in turn fastened to the lower end of the bushing. In closing, the wedge-shaped blade enters between the stationary contact fingers, Fig. 2, and in opening the arc is broken between the top edge of the wedge-shaped blade and the flared ends of the finger contacts, Fig. 3.

Adjustment of the contacts is made in a similar manner to that previously explained. However, in bending, use a piece of fiber or wood against the contact surfaces, as the use of a metal wrench or bar against these surfaces is liable to mar the contact surface and do more harm than good.

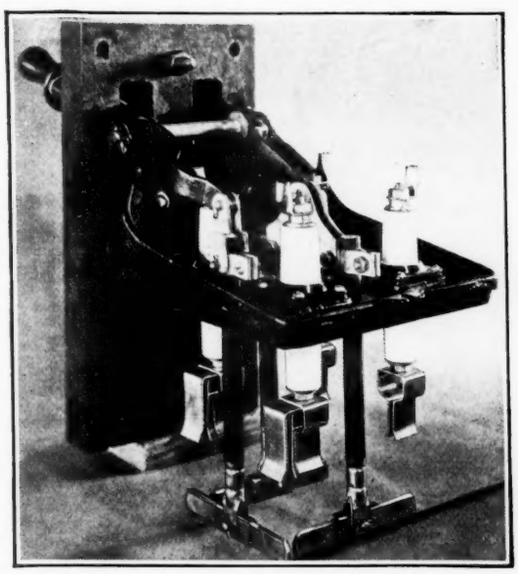


Fig. 1—Oil switch with spring contacts and flat movable blades

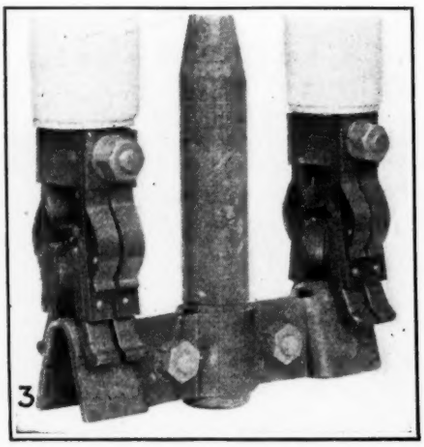
Finger Contacts with Arcing Tips

Figs. 5 to 7 show another type of finger contact, but here the addition of removable arcing tips *A* is used to relieve the main contact surfaces of any burning when the contacts open under load, as the final break of the arc takes place between these tips on the stationary contacts and the ends of the wedge-shaped blade (see Fig. 6). In case it is necessary to replace the arcing contacts, these may be removed by withdrawing their holding screws and new contacts substituted. Contact

adjustment for this type is made the same as for the previously described types.

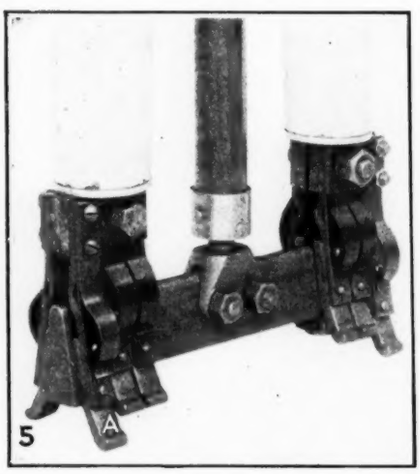
Brush-type contacts are shown in Figs. 8 to 10. Here two complete sets of contacts are employed. The main current-carrying contacts *A* are composed of stationary copper leaves bound together and fastened to their contact support. These make contact with a movable block contact *B*. At either end of this block contact is screwed an auxiliary contact piece *C*, which makes contact with its respective stationary contact member *D* as in Fig. 9. The auxiliary contacts close the movable contact closes against the brush surface, a wiping motion results and cleans the contact surface, insuring good contact with the brush laminations spread slightly. The auxiliary contacts may be removed when necessary by withdrawing their holding elements.

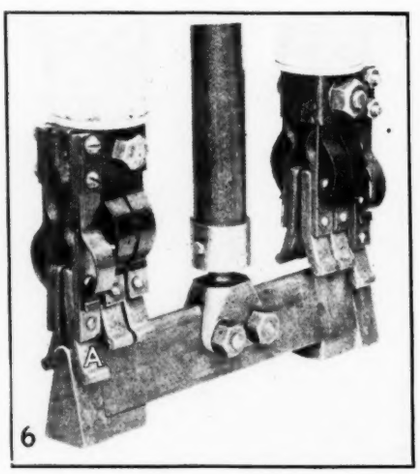
Figs. 12 to 14 show what is known as a leaf contact. Stationary block contacts *D* with arcing tips *E* screwed to their ends make contact with the movable contacts, which consist of primary contacts *A* made up of a number of copper leaves clamped together at their center and connected to the movable operating rod

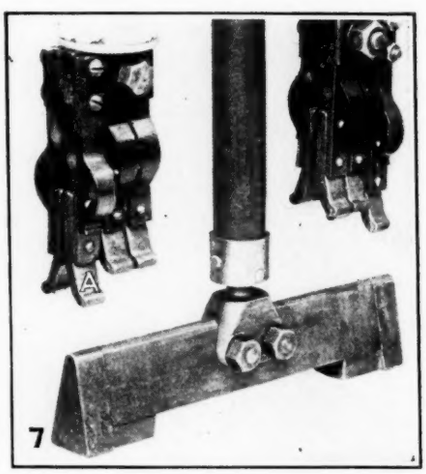


Figs. 2 to 4—Oil switches equipped with finger type of contacts and wedge-shape movable blades in three different positions

Figs. 5 to 7—Oil switches equipped with finger contacts, wedge-shaped movable blades and auxiliary breaking contacts







first and open last, with the result that the arc, drawn in opening a load, is broken on the auxiliary contacts and the main contacts protected.

To test the contact area, a thin piece of paper *E* should be placed between the brush contacts *A* and the breaker closed, as in Fig. 10. The contact impression on the paper should show at least 85 per cent of the available contact area making contact. Fig. 11 shows about how much of the contact surface should be imprinted on the paper.

For this particular type of brush contact the toe of the brush (that part nearest the movable contact rod) should be slightly below the heel, so that when along with the secondary contact *B* and tertiary contacts *C* with suitable arcing tips, Fig. 12.

In closing the breaker, contact is first made between the tertiary, then the secondary contacts, Fig. 13, and then the main leaf contacts in the order named. In opening, the reverse is true and the arc is broken finally on the arcing tips of the secondary and tertiary contacts. These arcing tips are held to their supports by screws and can be removed when necessary by withdrawing their holding screws. Adjustment of the leaf contact surfaces may be done by filing them with a fine file.

Connections—As the jar and vibration caused by the

breaker operation may loosen the connections to the studs of the breaker bushings, these connections should be examined at the regular inspection period. Loose joints will result in overheating of the buses and studs.

Taped connections on buses, etc., must be examined at this time to see that all insulation is intact and has not been torn or cracked, making it a danger instead of a safeguard.

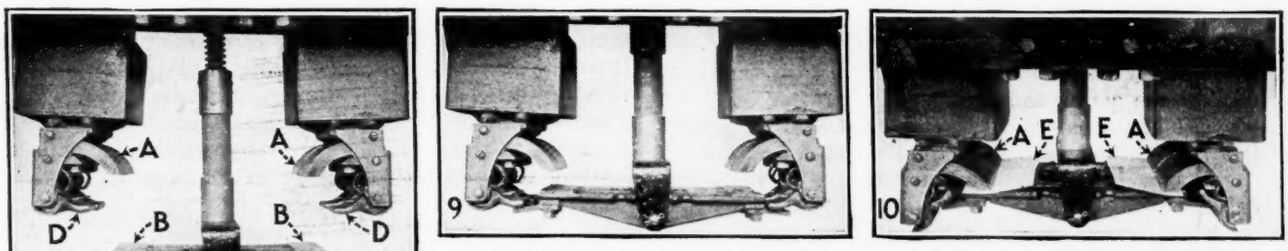
In tightening cable terminals or connection bars to the bushing studs of the oil circuit breaker, avoid turning the stud, as this will throw the contact surfaces out of alignment. Terminal connections should be tightened with the lower end of the stud securely held in its position by a wrench or other means.

The bushing studs should not be forced to carry cable or busbar strains, as a side thrust on the stud may ened when necessary, as loose bolts will allow the bushing to move, changing the contact alignment and possibly causing poor contact.

When it is necessary to change the bushing alignment to secure proper contact of the switch, tap the bushing carefully with a rawhide mallet to change its position.

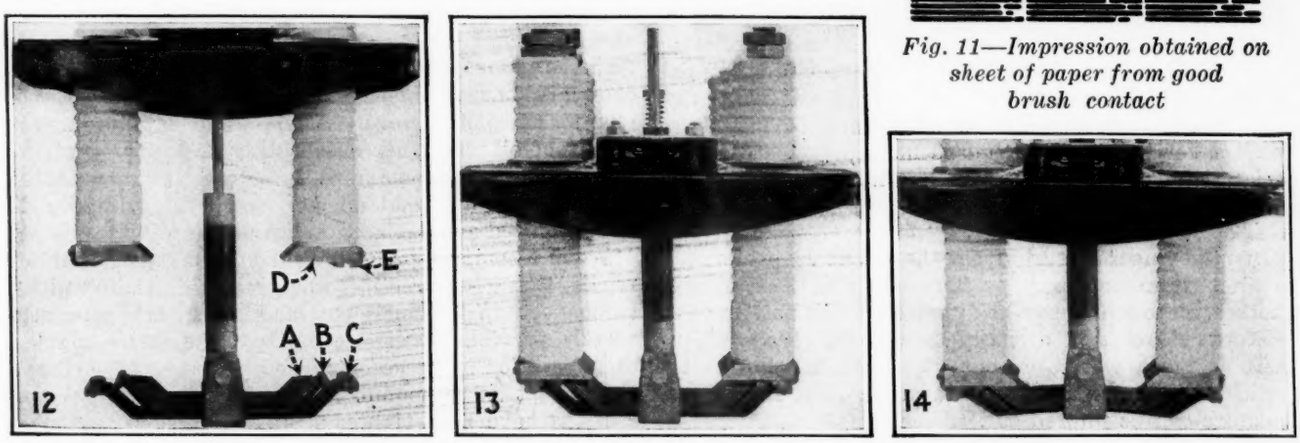
Oil Tanks—In removing the oil tank for inspection purposes, do not allow the tank to strike the contacts, as these surfaces may be jarred out of their correct alignment. Inspect the tank lining. As the tank lining is used to insulate the metal tank from the contact mechanism of the breaker, holes or rips in the tank lining will destroy its effectiveness.

After removing the oil, clean the tank, removing all sediment that may have collected on the inside. When



Figs. 8 to 10 — Brush-type contacts with auxiliary make and break contacts

Fig. 11—Impression obtained on sheet of paper from good brush contact



Figs. 12 to 14—Brush-type contacts with auxiliary and tertiary contacts

alter the bushing alignment and in turn affect the proper relation of the contacting surfaces.

Bushings—The oil circuit breaker bushings should be examined at the regular inspection periods to see that no cracks have occurred through the jar resulting from operation of the breaker. Bushings must be kept clean. Dirt, grease, soot, etc., must not be allowed to accumulate on the bushing surfaces, as the voltage flash-over value of the bushing may be lessened materially and trouble occur through leakage or possibly a direct flash-over.

Needless to say, bushings must be examined more frequently when located where abnormal conditions exist, such as cement dust or acid fumes.

Attention should be given to the method used in supporting the bushings to the breaker frame. If supported by small holding bolts, these should be tight-

replacing the oil, fill the tank with oil to its correct height as shown by the oil line or oil gage. In replacing the tank, be sure that the felt gasket (if one is furnished) is in position around the tank rim, as this lining is provided so that a tight joint is made between the top end of the tank and the breaker supporting frame. This gasket is intended to reduce the amount of oil that might be thrown out of the tank when the breaker contacts interrupt current. The tank must be securely fastened in position, as great strain may be thrown upon it when opening a load with the breaker.

Oil—At the regular inspection a sample of oil should be taken from each breaker tank and given an insulation test. The oil sample should be taken from a point about midway between the contacts and the bottom of the tank. A brass or glass tube, called a thief, may

be used conveniently for this purpose. Both the thief and the container used in obtaining the sample should be cleaned with gasoline and dried before being used.

It is desirable to use a glass receptacle (bottle) for the oil sample, as when water is present, it may be readily seen. An investigation should be made when water is seen in the oil and the cause remedied. Leakage of water into the tank may be caused by a broken gasket around the tank rim or by the oil tank not being fastened tightly to its support, allowing water to get into the tank.

Testing the oil may be done by means of the standard oil-testing spark gap. This gap has disk terminals one inch in diameter, spaced one-tenth of an inch apart, mounted within a cup receptacle for holding the test sample. This receptacle should be thoroughly cleaned and rinsed out with a portion of the oil to be tested before a test is made. Then the cup receptacle should be nearly filled with oil and allowed to stand a few minutes to give air bubbles a chance to escape.

The voltage across the gap should be raised at about 3,000 volts per second until the gap flashes over, breaking down the oil. The average break-down voltage of five tests is a good indication of the dielectric strength of the oil. One break-down should be made on each filling and then the testing cup emptied and refilled with more oil from the sample container. If these tests show the dielectric strength of the oil to be less than 16,500 volts, the oil in the tank from which the sample was obtained must be filtered or new oil placed in the tank. This new oil should be given a test before being placed in the tank, as moisture may have gotten into it and reduced its dielectric strength. New oil should test at least 22,000 volts, and when the test falls below this value, it should not be placed in the breaker tank, but should be filtered to increase its dielectric strength and remove any moisture.

Removing Moisture From Oil

In removing moisture from the oil, it is preferable to filter from one tank or barrel and discharge into another, although it may be drawn from the bottom of a tank or barrel and discharged into the top. When there is much water present, it should be allowed to settle out of the oil and then drawn off. The remaining moisture can be filtered out.

If the oil testing outfit is not available, the presence of moisture in new oil can be determined by heating rapidly a small quantity of oil in a dry saucer to about 120 deg. C. (250 deg. F.). If a cracking noise is heard, this is an indication of moisture in the oil.

After an oil circuit breaker has opened a very heavy current such as that caused by the development of a fault on the system, the oil should be inspected and if its appearance shows the presence of carbon, the oil should be tested and filtered if necessary, or replaced with new oil if testing facilities are not available.

Inspection period—The regular inspection previously referred to should be given once every three months for oil circuit breakers when their location does not subject them to unusual or abnormal conditions, such as the presence of cement dust, acid fumes or other harmful substances. In case the oil circuit breaker is so located, the inspection period may occur more frequently to insure successful operation of the device, the frequency of the inspections depending upon the severity of the conditions under which the oil circuit breaker is called upon to operate.

Diesel-Engine Air Compressors

Some Common Troubles and the Symptoms That Precede Them

By Robert Melrose

IN THE earlier days of the Diesel engine the air compressor was a continual source of trouble mainly due to the improper balancing of the stages, faulty lubrication and defective design. Experiment and practical experience have to a great extent eliminated such undesirable conditions, but occasions frequently arise where, perhaps owing to bad lubricating oil or some foreign substance having a deleterious effect on the metal, minor defects ensue.

For fuel-injection purposes an air pressure of 65 to 70 atmospheres is required, this pressure being attained in current practice by compressing the air in three stages, the compressor being driven off an extension of the crankshaft. Both differential and steeple types are used, but as the former has been adopted more extensively, the following remarks will be confined entirely to this particular type of compressor.

Finding the Correct Quantity of Lubricating Oil

The correct quantity of cylinder lubricating oil required by an air compressor can be determined only by careful observation. An excess of oil will accumulate at the bottom of the intercoolers in the form of sludge and will require to be blown out at frequent intervals. This sludge, which contains a high percentage of water, forms a gummy substance, which, if drawn into the cylinders, has a tendency under the action of heat to glue up the piston rings. On the other hand, a meager supply of oil will cause overheating and scoring of the cylinder walls, accompanied by excessive wear of the piston rings, and what oil does reach the cylinder will be carbonized and probably choke up the valves.

When a compressor has been stripped for overhaul or repair, it is good practice, when replacing the oil pipes, to connect up the oil pump and flood each pipe separately previous to connecting to the cylinder nipples, this operation being accomplished by means of the hand attachment on the pump. A few strokes after all connections have been tightened up will insure an immediate supply of oil with the starting up of the engine.

Determining the Condition of the Piston Rings

There are generally three pressure gages fitted in close proximity to the compressor; with connections to the intermediate-pressure delivery, low-pressure delivery and low-pressure suction valve chests respectively, the high-pressure gage being attached to the blast bottle. By observation of the variation in pressure of the different stages a good indication can be obtained of the condition of the piston rings.

In the event of the high-pressure rings starting to leak, the air will find its way into the low-pressure stage; consequently, the low-pressure gage will show an increase of pressure and the total output of the machine will fall off perceptibly. Should the leakage become excessive, the low-pressure relief valve will begin to blow.

At the intermediate-pressure rings, leakage merely means an escape of air to the crankcase and of course a reduction in compressor output. Leaks by the low-pressure piston rings would cause a passing and

repassing of air between the low-pressure and intermediate-pressure stages at either compression stroke. The low-pressure gage would indicate a slight increase with a corresponding drop of pressure on the intermediate-pressure gage.

A slight leakage of air into the cooling-water space, due perhaps to imperfectly expanded intercooler tube ends, can be detected immediately by violent fluctuations of the cooling-water gage needle.

How Derangement of Valves Is Indicated

Derangement of the suction and delivery valves will be immediately indicated by a departure from normal pressures as observed on the stage pressure gages. A choked low-pressure suction valve will show the same characteristics as excessive throttling. A choked intermediate-pressure suction valve will restrict the flow of the air from the low-pressure stake and consequently raise the low pressure with a corresponding reduction in the intermediate pressure.

A choked high-pressure suction valve will restrict the flow of air from the intermediate-pressure stage, which in turn will affect the low-pressure stage, causing the pressure to rise in the latter two stages, but will show a decrease in the high pressure, as indicated by a falling off in pressure at the blast-air bottle. Suction valves leaking will cause a rise of pressure in the preceding stages with an exception in the case of a leaking low-pressure suction valve. This defect will be denoted by a blow back at the compressor inlet.

Intercoolers have been known to burst with disastrous consequence owing to excessive thinning of the tubes by corrosion or erosion. Corrosion may be caused by the formation of organic acids due to oxidation of the lubricant or again, to galvanic action due to the presence of dissimilar metals.

If an engineer has any doubts as to the behavior of the lubricant, he should verify its purity by the following test: Take a sample of the oil and boil it. Insert a blue litmus paper, and if it turns pink or red, it denotes with certainty the presence of acid. A clean copper wire immersed for a few hours in oil containing acid will become discolored.

Coils and Tubes Should Be Carefully Watched

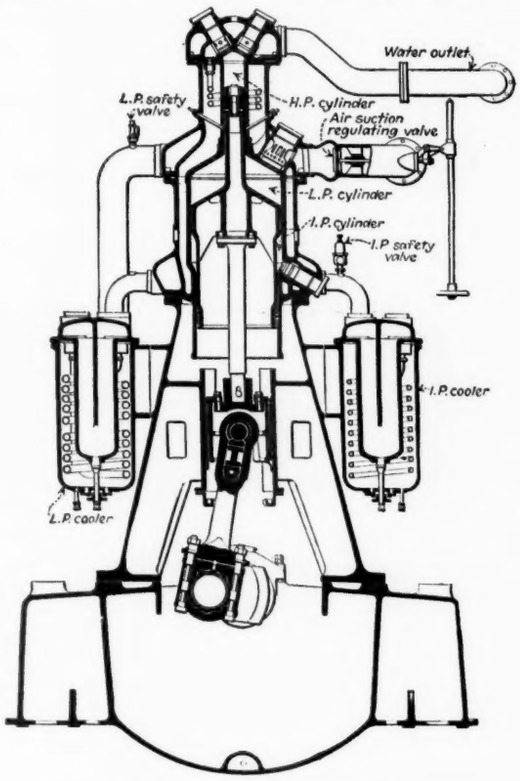
When an intermediate-pressure or high-pressure cooler tube or coil gives way, it generally bursts the casing also, imparting sufficient velocity to the fragments to cause injury to the operator. Intercooler and aftercooler casings have been known to burst even when fitted with safety valves, so that it behooves the engineer to keep a careful watch on the coils and tubes. From an insurance point of view it should be good practice to weigh coils when new; detach them at intervals and after cleaning, weigh them again. This method will give a fair indication of the deterioration of the metal. Erosion may be caused by a high-velocity cooling system carrying particles of grit, the continuous abrasive action ultimately thinning the coil or tubes with the results already described.

The vaporization of excessive lubricating oil has been suggested as a probable cause of explosion in air compressors, and although no instance has come under my notice of this having occurred, the fact remains that this condition constitutes a possible hazard.

Blast-air pressure is controlled in most cases by throttling the suction to the first stage. This may be accomplished either by hand or by automatic control, the governor actuating the compressor throttle simultaneously with the fuel-oil supply to correspond with variations in the load on the main engine.

Owing to the formation of moisture in the air as it passes through the coolers, it is the practice in some plants to keep the drains slightly open, just sufficient to get rid of water and surplus oil without blowing off an excessive amount of air.

Air compressors that are designed on a generous scale—that is, having a large reserve capacity—are susceptible to trouble due to excessive throttling, thereby upsetting the stage balance. To the reader it may appear a paradox, but it is an accepted fact that throttling the suction of the first stage increases the



Diesel air compressor with intercoolers

temperature in the high-pressure stage. This may be explained by pointing out that as the terminal pressure remains constant, the ratio of compression in the high-pressure stage of a machine with restricted air supply is greater than it would be with free inlet, consequently the valves and piston rings are liable to become adversely affected by the decomposition of the lubricating oil under the increased temperature. Again, by throttling the suction, a vacuum is created in the low-pressure stage, thereby increasing the tendency of foreign matter to be drawn into the machine.

It cannot be too forcibly impressed on all that have Diesel engines under their charge that cleanliness and systematic routine is the keynote of successful operation.

As recently explained by the Boiler Code Committee, the A.S.M.E. Boiler Code does not specify whether boilers should be calked on the inside or outside. So far as the Code is concerned, they may be calked inside or outside or both.

Reconstruction of Oshkosh Water-Works

Synchronous-Motor Gasoline-Engine Pumping Units Replace Old-Time Steam Plant

By J. SAM HARTT*

IN THE Middle Western States the average water-works is from thirty-five to forty years old. As this exceeds the economic life for boilers in this service and pumping equipment, water utilities generally are at a point where their old equipment is worn out, obsolete and inadequate and the operators have the problem of rebuilding and enlarging their plants. They can do this by installing new and larger boilers and pumping equipment and continue to operate in the old manner, or they can employ a competent engineer to investigate the situation with the view of improving both equipment and methods of operation and then building to meet these improvements.

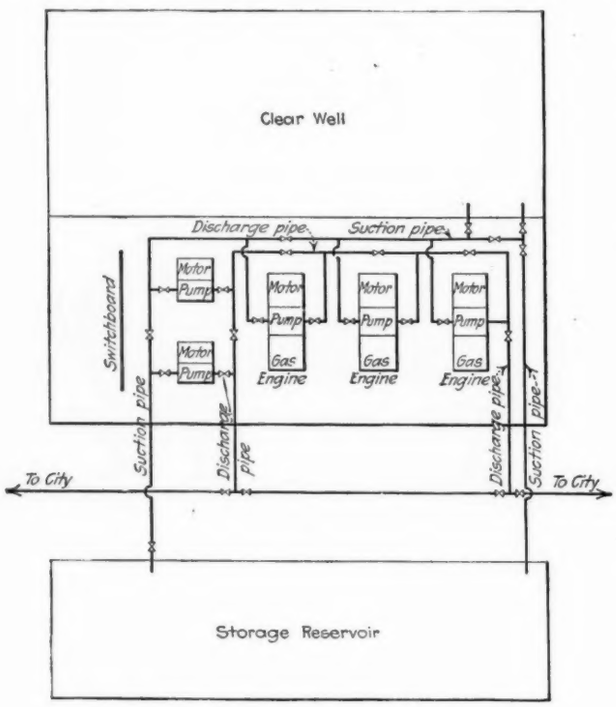


Fig. 1—Water-piping layout of new plant

Recently, the writer was retained to investigate and rebuild the municipal pumping plant for the City of Oshkosh, Wis. A brief outline of the work is presented with the anticipation that it may assist in bringing to light the complexity of the situation and the method of procedure. A study of existing conditions revealed the fact that there was available an up-to-date filtration plant situated on the banks of Lake Winnebago, using motor-driven centrifugal pumps to elevate the water from lake level to the sedimentation basins. A steam-driven pumping station, consisting of four boilers and two 2,500 gal. per min. Holly steam pumps, took the water from the clear wells and pumped it to the city distribution system at 60 lb. pressure for domestic service and at 100 lb. pressure for fires. No standpipe had been provided.

The boilers were in poor condition, two of them having been condemned by an insurance company. The steam pumps were forty-one years old and besides being badly worn, were inadequate for present requirements. During the summer, when considerable water was being used, it was necessary to operate both pumps for domestic service, leaving only the additional capacity in the pumps over and above domestic requirements, for fire stand-by. This made it imperative that both pumps be in good condition at all times to handle the load. Owing to low economy the operating expenses of the pumping plant were excessive.

How the Project Was Developed

A careful investigation of the distribution system showed that it was adequate for the city's needs for some time to come and that by putting in a few tie connections, sufficient pressure could be maintained in all parts of the city at all times. It was discovered that about 60 per cent of the water services were unmetered and that considerable pumpage was being wasted by the flat-rate consumers.

An investigation of fire insurance rates showed Oshkosh to be rated as a sixth-class city, the fire department being only partly motorized, but otherwise adequate.

From the local electric company it was found possible to obtain an average rate of about 1.6c. per kw.-hr., the current to be supplied at 4,000 volts. Use of electric energy at this price figured better than to pump water in a plant of the size by steam or oil engines, under the conditions existing in Oshkosh.

Taking all these factors into consideration, the new project was developed. The fire insurance rating of the city was bettered by the addition of three pieces of motorized equipment and the assurance of 50 lb. water pressure at the hydrants at all times. The additional fire fighting equipment cost $44,000 and will pay for itself in the decrease in the fire insurance cost to the property owners.

Investigation of the old pumping plant showed that the average pumpage was from 2,000 to 3,000 gal. per min. for domestic day-time service, 1,000 to 1,200 gal. per min. for night-time domestic service, and as high as 5,000 gal. per min. during fires. Using the maximum requirement as the basis, it was decided to install three 2,500-gal. pumps and two 1,250-gal. pumps, giving a total capacity of 10,000 gal. per min., or about double the maximum pumpage ever recorded.

It was found that if 60 lb. pressure could be maintained at the pumping plant at all times, it would give sufficient hydrant pressure in any part of the city to maintain the pressure needed by the motorized fire pumps and also supply sufficient water. It was considered better to maintain a constant pressure than to raise the pressure during fires, because of the additional expense attached to raising the pressure over the

*Associated with Byron T. Gifford, Consulting Engineer.

entire distribution system, and because with an even pressure it would be less difficult to maintain the distribution system free from leaks.

After determining that electric drive was preferable, it was decided to electrify the plant. The electric company was willing to build a separate main feeder line from the power plant to the water-works on 40-ft. poles, storm guyed at each corner, with extra large conductors to be used for no other purpose than supplying the water-works. In addition to this the electric company was willing to make a connection to the waterworks plant from the regular distribution system to be used in cases of emergency. To further insure uninterrupted service, it was decided to install gasoline engines with flexible couplings on the opposite end from the motor of the three 2,500-gal. pumps to be used at times when the electric service should be down unavoidably. For this service centrifugal pumps were selected, owing to their efficiency and the ease with which they could be driven by either motor or gasoline engine.

As a further assurance of uninterrupted service ring systems of piping were employed, so that the breakage of any valve or fitting would not interfere with plant operation. The piping was placed accessibly in the basement under the operating floor, which was depressed so that the pumps would have at least one foot head on their suction side at all times. Fig. 1 gives the layout of the plant piping, showing the suction and discharge loops and the valves. The photograph shows the arrangement of the equipment.

With the electric service supplied at 4,000 volts, it was decided to eliminate transformation losses by installing motors designed for this voltage, and to minimize manual operation, push-button control was arranged for all motors.

Each of the three 2,500-gal. pumps can be driven by a synchronous motor or a gasoline engine, while the two 1,250-gal. pumps are driven by slip-ring motors under pressure control from the discharge mains. With this arrangement a constant pressure on the distribution system can be maintained by setting one of the 2,500-gal. pumps for a fixed load and letting a 1,250-gal. pump take up the variations.

A weakness in the plant as it now stood was that the low-head pumps in the filtration plant were electrically driven and any interruption in electric service would make it impossible to pump water from the lake to the sedimentation basins. These basins, together with the clear wells, will supply the city for only a short time, so that it was thought that some stand-by means of running these low-head pumps should be devised. Arrangements were made, therefore, so that one of the synchronous motors in the pumping plant could be run as a generator by driving it through the 2,500-gal. pump with the gasoline engine. This gives sufficient capacity to drive the low-head pumps and, if desired, one of the 1,250-gal. service pumps, so that the water-works can be operated for a considerable length of time without service from the electric company if the latter service should be interrupted.

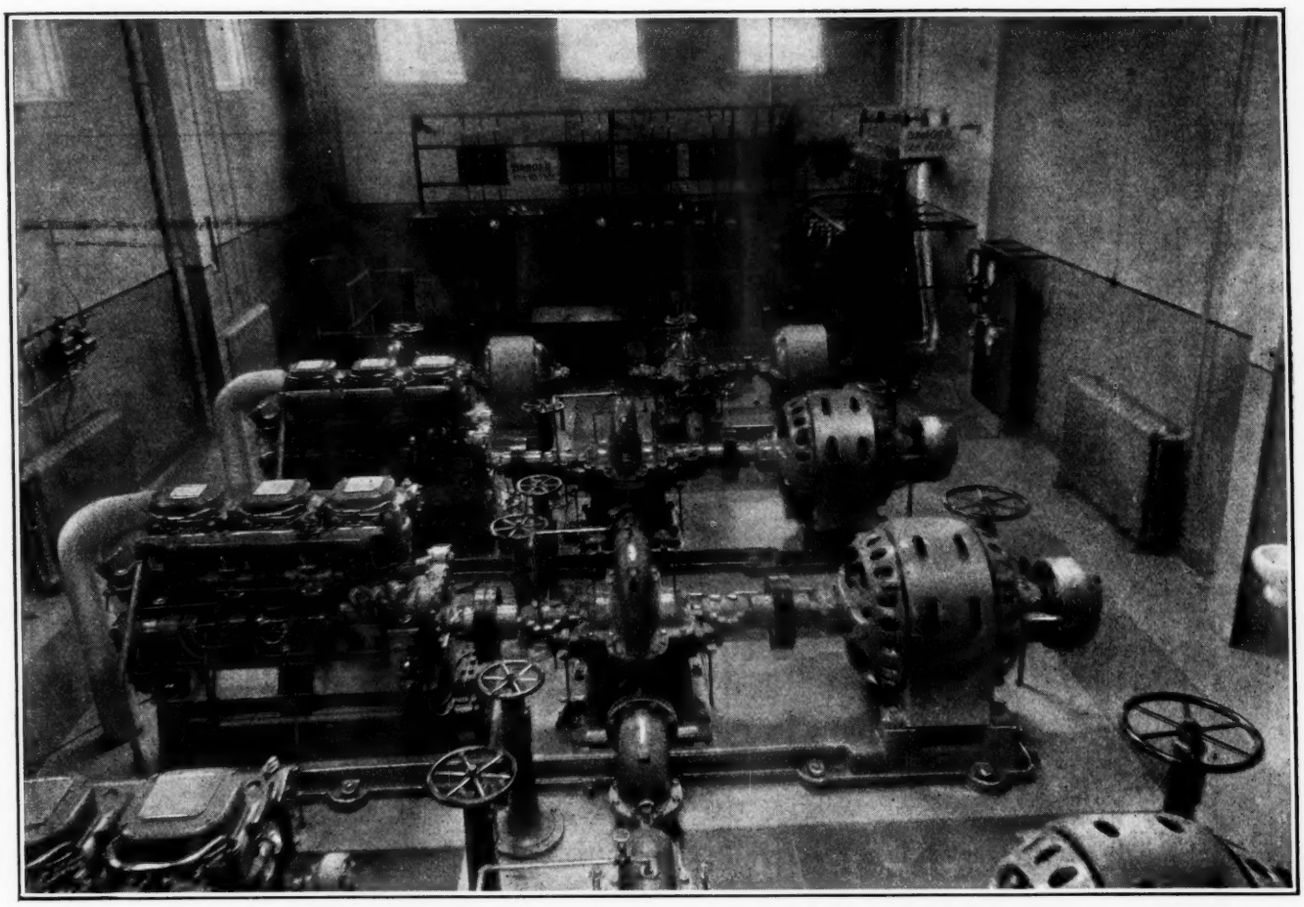


Fig. 2—Interior of new pumping plant serving the City of Oshkosh, Wis.

An Ancient Indicator

By GEORGE F. NORDENHOLT
Department of Mechanical Engineering, Lehigh University

THE Mechanical Engineering Department of Lehigh University has in its museum a steam-engine indicator of great historical interest. Fig. 1 is a photograph of this instrument taken with a modern indicator in its box, placed beside it. This gives a general idea of the construction of the older instrument and its comparative size. Fig. 2 shows the old indicator taken apart, and Fig. 3 is a diagram taken with it.

Has No Reducing Motion

The indicator has no pencil reducing mechanism, the pencil arm being attached directly to the indicator spring, as shown in Fig. 2. A hinged pencil arm enables the operator to press the pencil against the card.

The indicator spring is permanently attached to the indicator. It is not possible to change the spring, the scale of which is ten pounds to the inch.

Vertical adjustment to permit drawing the atmospheric line at any desired elevation on the card, is

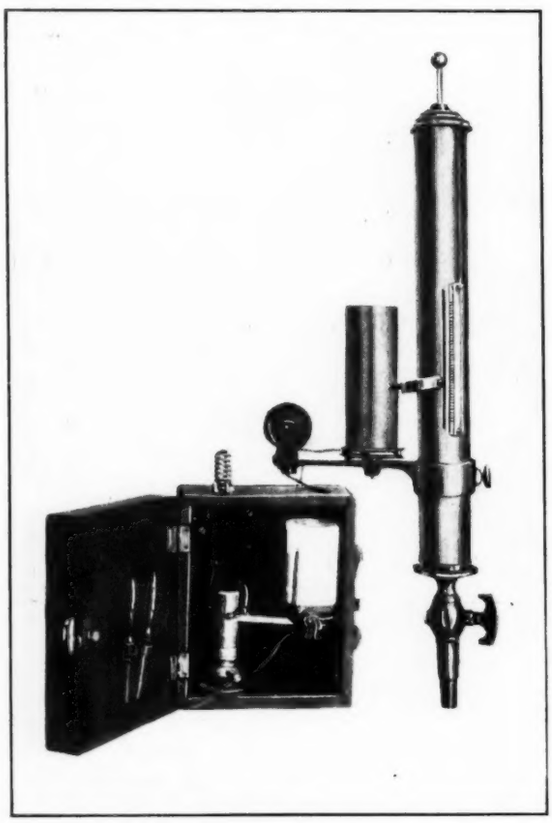


Fig. 1—Ancient indicator compared with modern instrument

obtained by loosening the thumbscrew that clamps the drum mechanism to the body of the indicator. The drum may then be raised or lowered.

The pencil arm carries a short pointer at the end where it is attached to the indicator spring. This pointer runs over the graduated scale on the body of the indicator, thus enabling one to read pressures directly.

The indicator is capable of recording a maximum gage pressure of only 30 lb. per sq.in. and a minimum pressure of 15 lb. per sq.in. below atmospheric.

With the exception of the springs the instrument is entirely of brass, the indicator cock being an integral

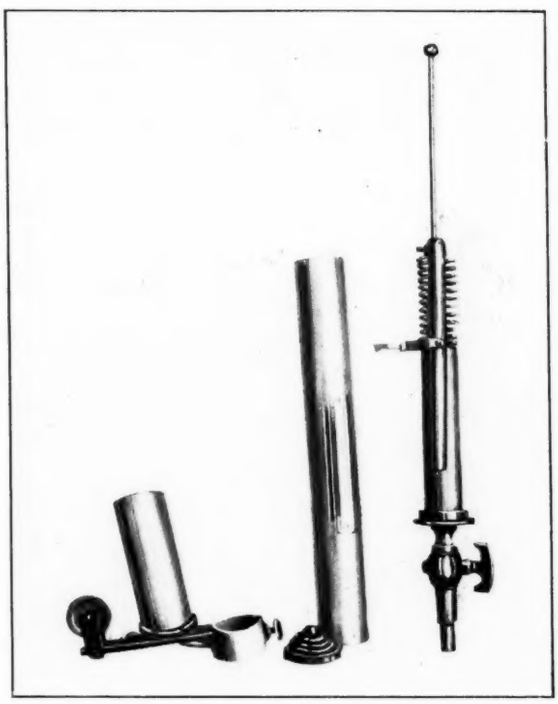


Fig. 2—Indicator disassembled, showing pencil arm moving directly with the spring

part of the indicator. The paper drum is practically identical with that on a modern indicator.

Little direct information is available regarding this indicator. The diagram shown in Fig. 3 was found in the indicator box. The only information upon it is the letters *L. E.* and the figures 1863. It is likely that *L. E.* was used to designate "lower end," meaning the crank end of a vertical engine, while 1863 may be the date the card was taken. The original card is now brittle and yellow with age, and the lines upon it had been traced over with ink in order to preserve them.

Admission Pressure Only 12.5 Lb.

It will be noticed that there are two "atmospheric" lines. Very likely the upper one was drawn while there was still back pressure behind the indicator piston. Assuming the lower line to be the true atmosphere line, the admission pressure shown is 12.5 lb. per sq.in. above atmospheric, and the exhaust line 10 lb. below atmospheric. The mean effective pressure shown by the diagram is 17.1 lb. per sq.in. These figures give one an idea of the pressures formerly used.

It is not known when this instrument was built, the only clue being the manufacturer's card tacked inside the cover of the indicator box. The inscription on this card reads as follows:

James Rodgers
Mechanical Engineer
257 Broadway 257
Between Walker and Canal Street, New York
Manufacturer of

Steam Ship Clocks, Meters for Counting the Revolutions of the Steam Engine, Iron Steam Gauges; also Atmospheric or high or low Steam Indicators; Vacuum Gauges, Steam Barometers for sale and made to order of brass or iron, of superior workmanship and finish.

Light Houses built of Cast Iron or other Materials, and fitted up complete with Lamp Reflectors and Machinery for Revolving Lights, put up in any part of the world.

N.B. Models made of any description at the shortest notice.

The instrument was presented to Lehigh University in May, 1886, by Holbrook F. J. Porter, consulting

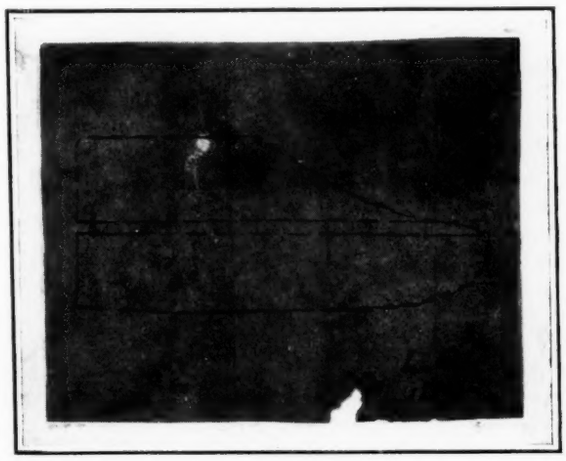


Fig. 3—Reproduction of old diagram (1863?). Lines preserved by inking

engineer, L. U., '78. In answer to a letter inquiring about this indicator, he states:

I do not know the history of the old indicator to which you refer. It was given to me by the Vice-President, Captain Babcock, of the Stonington Line of steamers, who found it with another in some junk at their wharf in Stonington.

Further inquiries failed to reveal who James Rodgers was. In reference to this, G. F. Felker, manager of the Technical Department of the Crosby Steam Gauge & Valve Company, writes,

. . . the indicator appears to be of the M'Naught type; it follows very closely that data we have of the old M'Naught indicator, and it is possibly a M'Naught indicator with a local agent's name attached to the case. . . . I could find no reference to Rodgers.

Considering the type of the indicator and the range of pressures to which it is adapted, and coupling this latter fact with the history of the steam engine, it is very likely that this instrument dates back to some time prior to 1850. Can any readers of *Power* give further information about this indicator or James Rodgers?

Combustion-Chamber Temperatures with Pulverized Coal

By J. G. Coutant

The modern boiler plant has reached a point of thermal efficiency beyond which little can be expected, and engineers, to effect further reductions in the cost of steam, are directing their attention more than ever to the basic principles of commercial economies. The problem is one of many complications, and to have the proper perspective one should view briefly the past and present state of development of boiler firing.

Coal is used to the greatest extent for steam making, being burned in mechanical stokers that have been selected for burning certain grades of coal according to their constituents of fixed carbon, moisture, volatile and ash. The stoker of twenty years ago, with natural draft and limited furnace volume burned fuel at rates now considered low. The equivalent evaporation of 5.18 lb. of water per square foot of heating surface per hour (150 per cent rating) was considered excellent, and 6.9 lb. evaporation (200 per cent rating) was termed exceptional operation.

Since then, remarkable progress has been made: The modern stoker has doubled boiler evaporations per square foot of heating surface. The furnace volumes have also been tripled or quadrupled, burning 1.5 to 2.4 lb. of coal per cubic foot per hour, the larger volumes having been found necessary to allow sufficient time in the furnace for better mixing and more complete combustion of the hydrocarbons that would otherwise pass off unburned.

Present Trend Toward Larger Units

It would appear that the logical progress is toward higher boiler evaporations per square foot of heating surface, larger furnaces, larger boilers and a demand for continuous operation over long periods, that will reduce the initial installation cost, fixed and operating charges.

Pulverized-coal firing of boilers during the last decade has been developed to such a degree, that at the present time no large stations are being designed without some consideration being given to pulverized-coal firing. It is conceded that this method of burning coal will meet the requirements and utilize low-grade fuels and at the same time maintain the highest boiler efficiencies.

A typical installation of such character is the Cahokia Station,[1] East St. Louis. The boilers, eight in number, are B. & W. cross-drum type, with a total heating surface of 18,010 sq.ft. The combustion chambers shown in cross-section, Fig. 1, are made with air-cooled walls, 11,440 cu.ft. volume, sufficient for burning fuel to operate the boilers at evaporations of 6.9 to 10.35 lb. per square foot of heating surface per hour (200 to 300 per cent rating), equipped with water screens of 580 sq.ft. and 365 sq.ft. projected area of boiler-tube surface exposed to the fire. This water-cooled surface has the effect of lowering the furnace temperatures for preventing the slagging of ash in the chamber.

The fuel burned is low-grade coal from the Belleville district, having approximately the following analysis: Volatile, 37.4 per cent; fixed carbon, 45.91; ash, 16.69; sulphur, 5.04 per cent. Calorific values as received,

[1] A description of the Cahokia Station appeared in the April 1 issue of *Power*.

9,945 B.t.u.; fusion point of ash, 2,000 deg. F.; fluid point of ash probably 2,150 deg. F. in oxidizing atmosphere.

These combustion chambers are considered extremely large as compared with the stoker furnace, the modern installations burning 1.5 to 2.4 lb., or 21,000 to 33,500 B.t.u. per cubic foot per hour, with no provision for extra boiler-tube surface to reduce the temperature of gases arriving at the tubes below the fluid point of the ash that would otherwise stick in the tubes.

Stoker and Pulverized-Coal Furnaces Compared

If the Cahokia boilers were stoker-fired, burning an amount of coal, it is assumed with boiler evaporations of 6.9 lb., 200 per cent rating and 12 per cent CO_2, 75 per cent boiler efficiency would be considered excellent operation and probably without slag troubles, based on the amount of coal burned per square foot of projected area of boiler-tube surface exposed to the fire. $\frac{18{,}010 \times 6.9 \times 970.4}{365} \times \frac{100}{75} = 440{,}000$ B.t.u. of coal burned per square foot of projected area of tube surface per hour, under which conditions the gases would arrive at the tubes at approximately 2,300 deg. F., a point that is within the danger zone of causing slagging troubles.

The powdered-coal furnace designed for boiler evaporations of 10.35 lb. of water per square foot of heating surface per hour, at 75 per cent boiler efficiency, would burn $\frac{18{,}010 \times 10.35 \times 970.4}{11{,}440} \times \frac{100}{75} =$ 21,100 B.t.u. of coal per cubic foot of furnace volume per hour, or $\frac{18{,}010 \times 10.35 \times 970.4}{(580 + 365)} \times \frac{100}{75} =$ 255,000 B.t.u. of coal per square foot of boiler-tube projected area plus the area of the water screen. With the proper admission of air there would not be any slagging difficulties and gases would arrive at tubes at approximately 2,100 deg. F. temperature.

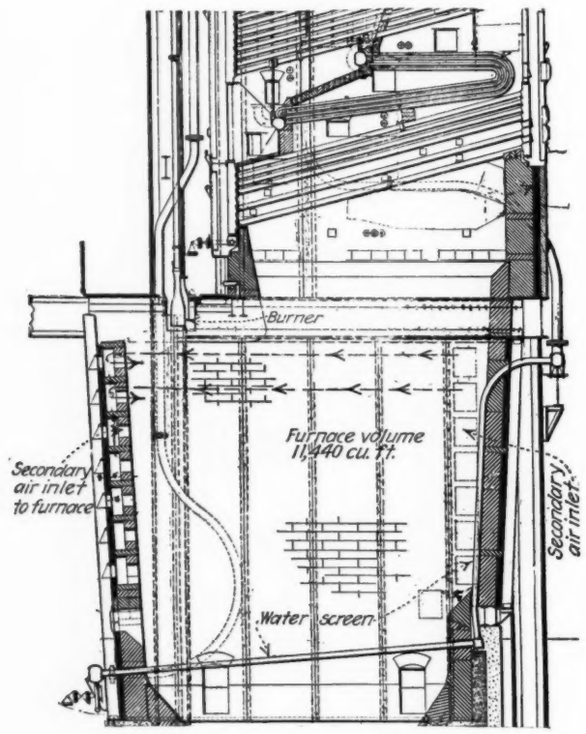


Fig. 1—Partial section of Cahokia settings

The modern stoker furnaces are smaller than powdered-coal furnaces burning approximately 21,000 B.t.u. to 33,500 B.t.u. per cubic foot per hour, while that at Cahokia is designed for 21,620 B.t.u. per cubic foot. It should be noticed that the furnace temperature, that of the gases arriving at tubes with stokers, is

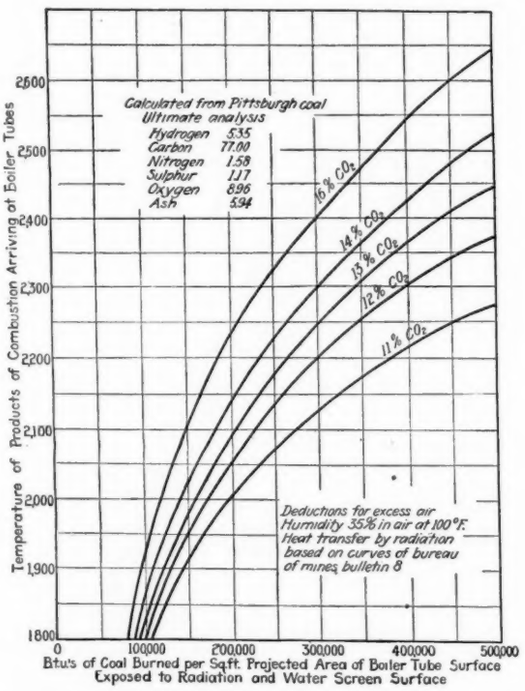


Fig. 2—Gives approximate furnace temperatures at different ratings and percentages of CO_2

2,300 deg. F. at approximately 200 per cent rating, and 2,100 deg. F. at 300 per cent rating, with powdered coal, a typical example of how boiler capacities can be increased 50 per cent when burning low-grade fuels in the powdered form.

It is apparent that pulverized-coal firing has opened up many new sources of fuel supplies, and in considering these it will be necessary for one to consider the effect of tube surfaces exposed to the fire and the transfer of heat by radiation to such surface. The chart shown in Fig. 2 has been calculated by the writer, and will give an approximate idea of what the furnace temperatures are likely to be under different conditions.

There appears to be considerable evidence from the results obtained from actual turbines that the efficiency of conversion of the available energy of the steam into kinetic energy is greater at low than at high steam velocities. Since the high-velocity ratio necessary for efficiency can be attained in two ways, either by reducing the steam velocity or by increasing the blade velocity, the most efficient type would appear to be that in which both steam velocity and blade velocity are kept moderate by adopting a large number of pressure stages.—From paper by Sir Charles Parsons.

Additional Steam Lines and Plant of the New York Steam Corporation

Steam for both power and heat is distributed at 125 lb. gage, while generation will be at 200 lb., in the proposed new steam station. Steam in all cases is utilized directly from the boilers without power production before entering the distributing mains.

THE distribution of steam for heating and power purposes in New York City is being substantially extended during the present year, with provision for further extensions during 1925 and thereafter. The New York Steam Corporation, operating the largest steam generating and distributing system in the country, supplies service for both steam power and heating in the downtown financial district and also for important uptown commercial and residential sections of the city.

The two distinct districts served by this company, are not physically connected. The downtown area, Fig. 1, contains the high buildings and narrow thoroughfares comprising the city's financial district. More than 80 per cent of the buildings subscribe to the company's service. The transportation of coal and ashes through the streets is thus greatly reduced, and space otherwise required in basements for the storage and handling of such materials may be utilized for other purposes.

Uptown District Rapidly Developing

The uptown district, Fig. 2, which extends north of Forty-second Street, comprises largely resident and apartment buildings in which growth and development are very rapid. This lies largely east of Seventh Avenue and Central Park. Additional feeder mains and extensions to plants steam equipment are being installed.

The uptown district is also being extended to the south of Forty-second Street as far down as Thirty-fourth. Apartments and commercial structures are here rapidly displacing the former residences. When completed, a single comprehensive system will serve this lower area and tie in with that above Forty-second Street.

Two Hundred Pounds Steam Pressure for Proposed New Plant

On the block extending east from First Avenue to the East River at Thirty-fifth Street there will be a new generating plant from which will eventually radiate four 24-in. mains designed for a working pressure of 200 lb. leaving the station. Until such time as this plant is completed, arrangements have been made for the purchase of steam from the New York Edison Company's Waterside Stations to offer the necessary reserves and to supplement the capacity of the company's existing plants. For this purpose two 16-in. feeders are being extended through First Avenue from Waterside Stations to connect with the Thirty-seventh and Thirty-sixth Street crosstown mains.

Steam from the Waterside Stations will be generated at the station pressure of 200 lb. gage and with superheat of 125 deg. F. This must be adapted to requirements for distribution which involves unusual problems of desuperheating and pressure regulation. It is essential that the steam furnished to the distributing mains shall carry no appreciable degree of superheat and that the pressure shall be so varied at the station that a constant pressure of 125 lb. will be maintained at the center of distribution at Madison Avenue. The installation of elaborate and flexible equipment at the generating station is made necessary to provide for the regulation, measurement and desuperheating of the steam which will vary between wide capacity ranges.

The distributing system utilizes refinements of conduit construction, including frequent manholes that

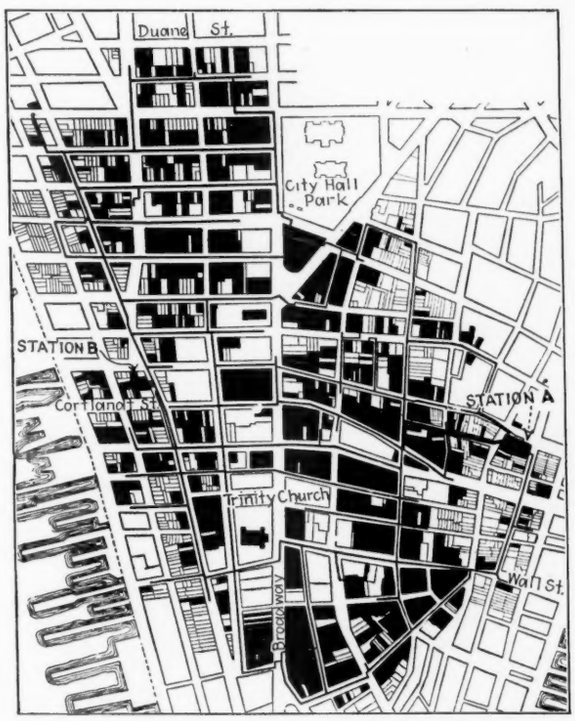


Fig. 1—Downtown district, where over three-quarters of the buildings utilize centrally supplied steam

may be quickly ventilated when opened and that have been but recently developed. All main flanged joints that do not appear in manholes are equipped with brass telltale pipes or tubes which are extended to manholes and offer immediate indication of the existence and location of leaks that might occur. Conduits and manholes are protected by an integral waterproof concrete mixture, and with drainage to adjacent sewers. Frequent trap stations and cooling-coil manholes provide for the removal, cooling and discharge of all main condensate to the sewer. Bronze metallic hose in sizes under 2 in. is used between manholes in connection with drain lines, which may be replaced without disturbing the street.

Main extensions to be completed and placed in operation immediately include a 24-in. feeder main extend-

ing crosstown through Thirty-seventh Street and Park Avenue and connecting with 20-in. and 16-in. secondary feeder mains in Forty-first Street, Lexington and Madison Avenues. From these will radiate 8-in. and 12-in. distributing mains on all cross streets, only certain ones of which will be completed and available for service during the coming winter.

During 1925 a second 24-in. feeder main will be extended through Thirty-sixth Street from First Avenue going south through Lexington Avenue, with secondary 20-in. feeder mains extending west through Thirty-third and Thirty-fifth Streets to Sixth Avenue. A 20-in. belt line main to be extended through Lexington Avenue from Forty-third Street to Fifty-eighth Street will complete a suitable system of feeder lines connecting the present generating plants at Sixtieth Street and East River, with the new plant at Thirty-fifth Street.

Heating is the principal load in the downtown district, while power is generated to a considerable extent from steam delivered in the uptown area. Steam from Station "A," Fig. 1, at Burling Slip and Water Street, is furnished to the outgoing mains at such pressure as to maintain 125 lb. gage at the most remote point from the station, within what is termed the high-pressure area, and which lies east of Broadway and south of Vesey Street. Steam pressure at Station "A" may vary from 130 lb. in summer time, to 160 under peak-load conditions during the daytime in winter.

The entire area north of Vesey Street and west of Broadway is largely a district of heating supply only, although there are a few buildings that use steam for power purposes at street main pressure. The downtown district is fed from the mains in the high-pressure area through valves that reduce the pressure to 100 lb. existing there.

During the coming winter all the steam supply for the low-pressure area will come from Station "A" and so reduce the pressure. At the same time Station "B," which is maintained as a stand-by reserve station, is to be operated only up to 100 lb. pressure, when called upon, and in such case serves only the low-pressure area west of Broadway and north of Vesey Street.

Subscribers to the company's service along the line of the new main extensions in the uptown area, Fig. 2, in the Forty-second Street area include the principal department stores, office and apartment buildings and residences. In addition to the direct benefits of economy, reliability and convenience of this service, as modern heating system control affords, the feature of cleanliness offers a substantial dollar value in this high-class mercantile district by the freedom from soot, coal and ash dust. Among the larger units to be supplied with the service are a refrigerating plant of approximately 1,000 hp. and the New York Central Railroad which receives a maximum of 3,000 hp.

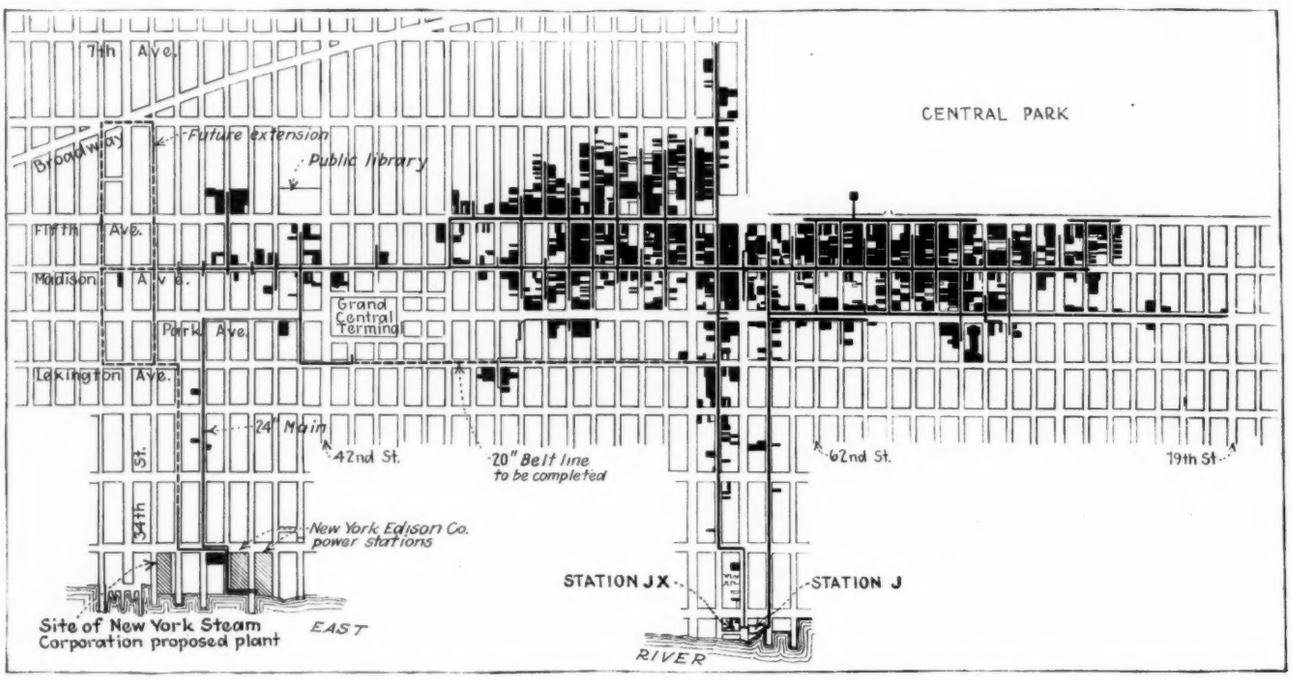


Fig. 2—Additions to the uptown district supplying steam for both heating and power

The best time to relieve the refrigerating system of air, decomposed ammonia and numerous other gases that go to make up non-condensable, impure or foreign gases is when the plant can be shut down for about five or six hours. Pump all the ammonia out of the evaporating coils into the condenser, shut down the compressor and allow cold water to run over the condenser coils for five or six hours, which will condense all the ammonia gases that are condensable. Then open slightly the purge valves which are provided at the top of each stand of coils, and watch them until a white vapor, closely resembling that of exhaust steam appears, when the purge valves should be closed. Purging condensers is necessary to the successful operation of a refrigerating plant, but is not a "cure-all" and should not be overdone.

Stage Efficiencies of Impulse Turbines

By L. J. Levit

The subject of stage efficiency was touched upon in an article published some months ago, entitled "Maintaining Impulse Turbine Efficiency by Checking the Condition Curve." This describes an approximate manner of plotting such a curve, so that the pressures to be expected in an impulse turbine might be roughly determined. As was stated in the article, such data, for accuracy, should really be obtained from the manufacturer. In lieu of this advice, that published by current handbooks could be utilized for approximating these conditions.

The efficiencies that may be expected in single blade ring or Rateau stages are indicated in Fig. 1, as plotted to the theoretical speed ratio, curves in this and other figures being taken from Goudie's "Steam Turbines."

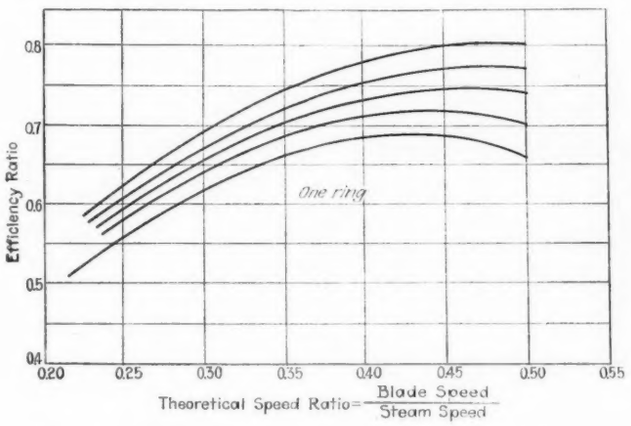


Fig. 1—Efficiencies for single-blade-row stages as obtained by tests at low pressures

Efficiencies are here seen to vary for a given speed ratio, which would result in utilizing different blade and nozzle angles. The theoretical speed ratio, on which this curve is based, represents the mean blade velocity, divided by the steam speed that would be obtained by expanding in a perfect nozzle. The actual speed ratio would represent the theoretical, divided by the square root of a nozzle efficiency, since the steam speed depends on the square root of this efficiency. The curves would be moved to the right, if plotted to actual ratios.

In ordinary turbines the efficiency of the high-pressure stages are lower than those of the low. Small blade angles and nozzle angles will tend, up to a certain point, to improve blade efficiency. If the angles are made too small, the gain is more than offset by the increased friction due to the greater length of blade channels. Small angles require excessive blade heights in order to provide necessary passage area, which tend also to increase the blade-pumping and disk-friction losses. The blade-pumping loss is often augmented by the fact that the admission at the high-pressure end of an impulse turbine may be only partial; that is, in many cases there are a number of nozzles each of which covers a part of the circumference, and except under conditions of overload, the entire area of the high-pressure blade row is not covered by steam from the nozzles.

Stage efficiencies, as may be expected with 2-blade ring velocity stage wheels, are indicated in Fig. 3. It is doubtful if an efficiency of 70 per cent, used in the aforementioned article, is possible in commercial impulse turbines, as indicated from this curve. It must be remembered, however, that improvements in velocity stages have recently been described at the World's Power Conference whereby, as may be inferred, the

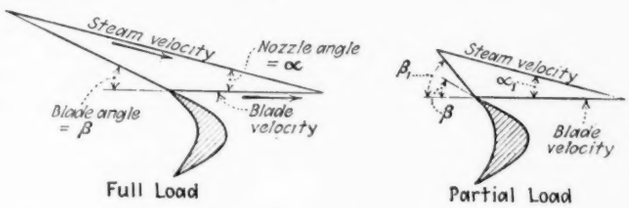


Fig. 2—Relative angle β of steam to blade, increases to β_1 at lighter load

efficiencies previously experienced, have been improved to some extent. Fig. 4, giving Bauman's results, indicates 68 per cent as the possible maximum, for low-pressure stages.

A lower speed ratio than that corresponding to maximum efficiency at full load should ordinarily be used, in order to secure the best service performance. In Fig. 2 is shown the effect of full load and partial load on the angle of the steam entering the blade. Thus, for full load, the steam is ejected from the nozzle at an angle α with the blade, if standing still, the length of this vector representing the velocity of the steam in feet per second.

The blade velocity is represented by the horizontal vector whose length corresponds to the actual blade speed in feet per second. If the blades were standing

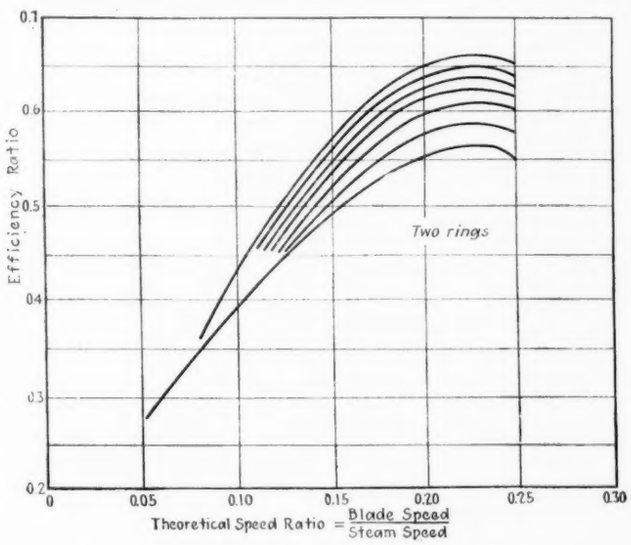


Fig. 3—Two-row velocity stage efficiencies from experiments by Lasche

still, the steam would hit at the angle α as shown, but since they move ahead with a certain velocity, the actual resulting angle will be a somewhat larger one as indicated at β for full load at the left. It will therefore, as a result, strike at a greater angle.

The condition at partial load gives even a more obtuse blade angle, β_1. Here, less steam is being passed

by the nozzle at a lower velocity. The relative blade angle at which the steam strikes the blades, β_1 is therefore greater than the blade angle β. In designing turbines, some compromise between these two conditions must be adopted. In other words, the most economical load at which the best condition of steam velocity for efficiency will hold, will probably be somewhat under the full-load rating.

In regard to stage efficiency, there is the equation, Stage efficiency = efficiency of nozzle × efficiency of blades × F. The factor F is for disk friction and diaphragm leakage and varies between 0.94 and 0.98, according to Goudie, as would be applied to a velocity stage. By using F as 0.96, and a nozzle efficiency of 96 per cent, and assuming a maximum blade efficiency of

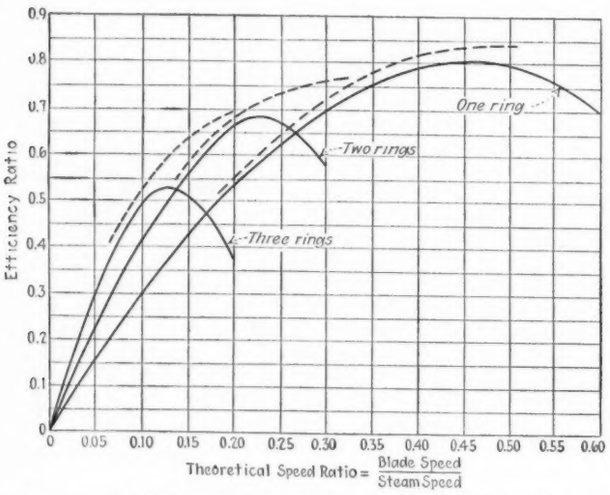


Fig. 4—Solid lines show various stage efficiencies as corrected for friction loss, by Bauman. Uncorrected, in dotted lines

73 per cent, we would obtain a stage efficiency of 67.3 per cent. This is probably high for many high-pressure 2-row velocity stages. The curves, Fig. 2 of the article referred to therefore appear to represent uncorrected stage efficiencies.

This will be seen to conform quite closely to the 2-row velocity stage ratio in Fig. 4. The dotted curves represent stage efficiencies uncorrected for losses of disk and nozzle frictions. High-pressure stages of one row of buckets in excess of 80 per cent net are obtained in the 2,400-kw. Brunner turbine, tests of which by Professor Stodola were published in the Sept. 23 issue.

Boiler Legislation in France

In 1810 the danger of smoke being emitted by steam fire-engine boilers led to the passing of an act that prescribed that authorization for steam boilers had to be obtained. Thirteen years later the necessity for having safety valves on boilers had made itself felt, and a law was passed that each boiler must have a lock-up safety valve. About this time the first instructions to boiler attendants were issued. Three years later a law was passed prescribing a severe hydraulic test for all new boilers. At the same time, and again in 1830, rules for boiler dimensions were issued. In 1832 further rules were added, prescribing the diameters of safety valves and insisting on the installation of fusible plugs.

In 1839 a retrograde movement set in, and the hydraulic test pressure was reduced in severity, and then, in 1843, a very detailed boiler law came into force. It was an improvement on the previous severe laws, but it bristled with new minute regulations, which seem to have grown in oppressiveness until, in 1865, they were swept away by a new law. About ten circulars were issued in the interval, the first one extending the scope of the act so as to include steam receivers. In 1847 three low-water indicators had to be fitted to each boiler. It was also stipulated that boilers must be laid down in certain directions, for it semed to have been noticed that in cases of accident destruction of property was greatest at either end of a boiler.

In 1849 Bourdon's pressure gages, a new invention, were allowed to replace the mercurial ones, and in 1861 rules for the thickness of steel plates were issued.

As already mentioned, in 1865 a law was passed which swept away many of the rules and regulations which government officials had been slowly building up.. Boilermakers were now free to build boilers of any dimension and any thickness and place them in any direction; safety valves might be any size, steam receivers were not boilers, and the test pressures which had started at three or five times the working pressure were now reduced to those adopted by the Manchester Steam Users' Association. Inquiries into boiler explosions were ordered, and strange to say, the law of 1810 was revived by certain clauses against the smoke nuisance. Furnaces might smoke, but steam boilers must not do so. In 1880 this regulation was dropped. In some of the previous laws, but more particularly in that of 1865, a system of boiler classification was adopted, which seems to have been based on certain speculations—that the larger a boiler and the higher its working pressure, the more dangerous it must be. By multiplying the volume of the water contained in a boiler by the permissible working pressure, a figure was obtained that fixed the class.

This regulation had to be modified in 1880, for even then it had been found that high-pressure boilers were not so destructive as low-pressure ones. This law, however, revived the old restrictions about the placing of boilers, but in a modified form. Boilers of the most destructive class were not to be placed nearer to a dwelling than 10 ft., and unless they were distant at least 33 ft. a thick wall of 39 in. or more had to be interposed. This law is apparently still in force, and is inconvenient in so far that the owner of a boiler is forced to shift its position, or at least to build the protecting wall, if his neighbor erects a dwelling within a distance of 33 ft. from the boiler. It is interesting to note that water-tube boilers, because of their small water volume, belong to the less dangerous (French) classes, and being subjected to fewer restrictions in that country, naturally grew in favor.

The most important clause of this act is the one that says that steam users must not only see that their boilers are in a safe condition, but have them inspected at intervals that are sufficiently close together. Another clause provides that if an inspector of mines has reason to believe that a boiler is unsafe, he may have it tested, but if the boiler is under the inspection of an association, their certificate will be accepted as proof that the boiler is safe. By this means nearly all French boilers have been driven into the arms of the various Boiler Associations.—*From Report of C. E. Stromeyer, Chief Engineer of the Manchester Steam Users' Association*

Using Indirect Radiation To Heat Combustion Air

HERE is an idea that at first blush seems rather promising, but may or may not be commercially feasible. At any rate it is worth thinking over. Picture a non-condensing isolated plant where, during the winter, part or all of the exhaust steam is delivered to indirect radiation through which air is forced by fans for heating buildings. In summer the coils and fans lie idle, assuming that the fans are not needed for ventilation. Would it be a paying proposition to run a duct from the coils to the boilers to supply them with preheated air during the summer months? In this connection allowance should be made for the extra steam consumption to run the fans if they are steam driven or for the current required to operate motor-driven fans.

Letters from *Power* readers, giving their opinions as to the feasibility of such an arrangement, are invited.

Points That Favor Welded Piping Installations

WHILE the great majority of piping installations in power plants are still made up with fittings and flanged or screwed joints, welded installations are sufficiently common to be no longer a novelty. Moreover, the use of the welding and cutting torches for this purpose is rapidly increasing.

It might seem at first sight that the choice between welding and other methods of joining up piping would hinge entirely upon which method showed the lower cost for direct labor and material, other things being equal. On this basis, taking a simple joint in a straight run of pipe as an example, the cost of welding in joining the two ends would be compared with the cost of a pair of flanges with bolts and gasket plus the labor of attaching the flanges to the pipe ends and making up the joint.

There are, however, a number of other factors to be taken into consideration, most of which seem to favor the welded joint. For one thing, there is a certain saving in drafting-room labor, since piping is largely cut to fit on the job and highly detailed layouts are unnecessary. For the same reason wastage due to drafting-room errors is largely eliminated, as is the possible loss of time due to lack of certain essential fittings in the stockroom.

Wherever the welding is done on a steam or hot-water line, the welding process must be credited with any resulting saving in the cost of heat insulation. As those who are familiar with insulating work know, the labor required for covering straight-run piping free from flanges or fittings is small, the chief cost being the material. But whenever a flange is encountered, it is necessary to saw a section of pipe covering to the proper length and usually to bevel the ends as well in order to avoid subsequent damage to covering when flange bolts are removed. This consumes time. Then there is the still more important question of insulating the flange joint. A medium-sized flange joint left bare will waste about one ton of coal per year on a steam line. The cost of covering the flange, even with material plastered directly upon it, is considerably greater than for the same length of straight pipe. Where the insulation is plastered directly on the flanges, it must be destroyed whenever it is necessary to get at the joint. If, to avoid this occasional destruction of the covering, a removable flange cover is constructed, the cost will average around six dollars for a single pair of flanges on a ten-inch pipe. The saving due to the elimination of flange insulation is therefore a substantial one. Incidentally, the line without flanges presents a better appearance. There is a similar saving in insulation labor when a welded outlet replaces a tee. With a welded outlet it is only necessary to cut a hole of the proper size in the straight run of pipe covering and to shape the end of the section on the outlet with a knife to fit the contour of the straight-run covering. This is a comparatively inexpensive operation.

For boiler work the objection is often raised that welded joints are unreliable. This objection has little weight in pipe lines because of the enormous excess strength of piping under normal conditions.

Obtaining Better Service From Wood-Stave Pipe

PIPE LINES of steel, concrete, wood or a combination of these materials have come to be an important part of many hydro-electric projects. Reliability and durability are of double importance in these conduits, since frequently a whole plant depends upon one pipe line for its continuous operation. Anything happening to the line would cause the shutting down of the entire plant. Failure of a pipe line is usually of a nature that requires a considerable period to get it back into service. Such failures not infrequently cause serious damage to property other than the pipe line itself, so that they should be avoided wherever possible.

Wood-stave pipe is now used under a wide variety of conditions in hydro-electric developments. The fact that it has been employed in sizes up to fourteen feet diameter and for heads up to three hundred feet shows that it has attained an important position. Its use has grown rapidly with the increased development in water power. However, this increased use has not been without a number of serious failures. These for the most part have been due to improper installation and care in operation rather than to any fundamental weakness in the design. If this class of pipe is properly installed,

protected and operated, its life is as long as any other material that can be used. On the other hand, if these requisites are not strictly adhered to, the results may be anything but satisfactory. For this reason the article in this issue, "Maintenance of Wood-Stave Pipes in Hydro-Electric Developments," and a second article, which will soon be published, should be of particular interest to designing and operating engineers of water-power plants.

Conditions under which wood-stave pipe are used are so varied that no set of rules can be laid down to cover all cases. Wood that has been buried in wet soil for hundreds of years has been found in a good state of preservation. This, however, is by no means proof that the best way to install a wood-stave pipe is to bury it in a trench, since soil condition is a very important factor and the pipe may not always be subjected to sufficient pressure to keep the staves saturated with water.

In operation careful attention should be given to inspection. This is particularly true since, if decay or other deterioration sets in, it should be detected at an early stage. Deterioration might be going on for a number of years without being discovered unless a system of periodic inspection is rigidly carried out. In the plant the machinery is directly under the attention of the operating crew and by its nature inspires attention. On the other hand, a pipe line may be in an isolated district, a fact that tends toward neglect.

There are many projects that are so costly that they become feasible and economical only by the use of wood pipe as a substitute for more costly material. If, by a proper attention to the fundamentals in installation and maintenance, its period of usefulness can be considerably extended, much benefit will follow and many projects that otherwise might be uneconomical may be brought into the commercial zone, thereby substantially increasing the utilization of our water powers.

The Air Preheater, and What Then?

MOST power-plant designers are today literally "on their toes" in an effort to extract more available heat units out of every pound of coal fired; or perhaps it would be more nearly correct to say, "to reduce the pounds of coal per kilowatt-hour at the switchboard." Whether coal prices of a short time back, professional rivalry, or an imbued desire to improve on past performances has provided the stimulus is difficult to tell, but all will agree that the pace is swift. Having satisfied themselves as to the advantages of the regenerative cycle, engineers are now turning their attention to the air preheater. This device is so new in American practice as to provide very little actual performance data, aside from tests in two or three plants. But one will not have long to wait. A number of installations have been made during the year, and in some of the plants now building several types are to be tried out.

It is generally conceded that the actual efficiency is likely to be more than the theoretical due to improved combustion, especially with low-grade coals, but to what extent the increased furnace temperature will cause clinkering with a coal of low fusing temperature remains to be determined, as also the effect on the refractories. In this respect European experience is of little value. To meet anticipated conditions, at least one of the stoker manufacturers is ready with new designs embodying special tuyeres and air zones to handle the air at high temperatures.

Whether the preheater will prove a serious competitor of the economizer is another point upon which there is not complete agreement. In a few plants, designed for maximum efficiency, provision has been made for both. It would seem that the bleeder heater is actually the more direct competitor of the economizer.

With the air preheater problem solved, as it is sure to be within a very short period, one speculates as to what will next receive the attention of power-plant designers. With the introduction of every new system or device a margin for further saving decreases and renders each additional step more difficult; and still, we realize only a relatively small percentage of the heat in the fuel.

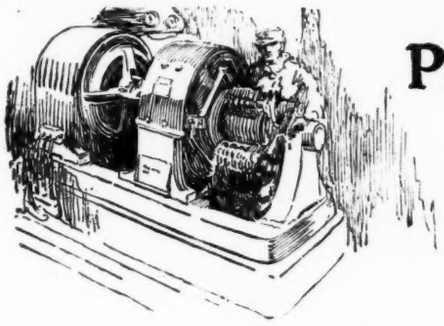
In his address made before the Technical Section of the Brooklyn Edison Club, on November 7, William H. Patchell, president of the Institution of Mechanical Engineers (Great Britain), commented on the excellent results obtained with single-pass boilers in one of the new British power stations. The boiler was of the inclined-tube type. Mr. Patchell wondered whether equally good results could not be obtained with Stirling-type boilers set without baffles. A number of cases have been reported recently where inclined-tube boilers have given excellent results without baffles. The results obtained with such boilers deserve careful consideration and analysis, to see to what extent the principles involved are capable of general application.

A glass of water in the lake is worth nothing. At the kitchen tap it has some small value. In the desert it may be worth a dollar or more. It is much the same with energy. As explained in the article on page 820, one million B.t.u. in coal at the mine mouth may be worth (that is, may *cost*) but seven or eight cents. The same amount of energy delivered electrically to the customer's meter generally costs at least eight dollars. Each of the many steps from mine to electrical consumer adds its own little burden of direct and indirect expense. Each step loses some of the original energy. The cumulative effect on energy cost is amazing.

High pressure and temperature pipe lines can be made lighter and simpler by substituting welded joints for the bolted type, at points where future disconnection is not likely to be required. Better knowledge of welded-joint design and material requirements would do much to influence general opinion in this direction.

The pilgrimage of American engineers to the World Power Conference last summer, followed by the return visits this fall of a number of prominent British engineers, should be more productive of better understanding between the two nations than any number of official visits of royalty or governmental representatives.

The American Association of Engineers is offering one hundred dollars in prizes for the best short essay on practical publicity for the professional engineer. It would seem that the engineer is at last emerging from the "shrinking violet" class.



Practical Ideas *from* Practical Men

Measurement of Air Removed from Surface Condenser

For some time past we have experienced trouble in maintaining the normal vacuum on one of our 5,000-kw. units. We have gone carefully over the joints on the turbine and condenser, but have not been able to find any leaks. However, I am of the opinion that the trouble is due to excessive air leakage and I should be pleased to receive through the columns of *Power* suggestions as to a practical method of measuring the air discharged by the air pump.

The air is removed from the condenser by a centrifugal hydraulic vacuum pump and discharged to the hurling tank with the injection water. The hurling tank consists of a 20-ft. section of 60-in. riveted steel pipe placed horizontally adjacent to the air pump. A section of 18-in. pipe welded to the tank close to one end and extending vertically about two feet forms the air discharge.

Probably some reader can suggest a practical means of measuring the air as it is discharged from the tank.

Buffalo, N. Y. A. R. ROBERTS.

Welding Patches on Boilers a Dangerous Practice

I recently had some experience with welded patches on a boiler that I believe will be of interest to the other readers of *Power*. The company by which I am employed wished to install a small boiler to be used only a short time and decided on a 350 sq.ft. locomotive-type boiler that had a patch about 8 in. long in each of the four corners of the mud ring, extending about 4 in. each way from the corner. The original metal had been removed and the patch laid on and two rivets driven to hold it in place while the welding was being done. It was lapped over the edge of the hole in the mud ring and butt-welded to firebox sheet and water-bottom.

I argued against this boiler, but the manager thought it would last as long as we needed it, so it was bought and installed. We were very careful in firing up and took about six hours to get up steam. When the pressure had reached 80 lb., we heard a hissing noise in the firebox and, on opening the door, found water spraying up against the crown sheet. It seemed to be coming from the mud ring. When we had cooled the boiler sufficiently we got inside and found that a crack about 4 in. long had opened up in the top side of one of the front patches and of course along the weld.

We called the welder in and had the crack welded up and fired the boiler up again. When the pressure had reached 100 lb., we started the engine that the boiler was to supply with steam. Everything ran along nicely for about an hour, when the water suddenly began to fall rapidly in the gage glass. We opened the door and found another patch had given way, so we turned the fire out (which was natural gas) and on inspection it developed that the two rear patches had opened up on the under side. To weld these would necessitate turning the boiler over on its side. By this time the manager's faith in welded patches on boilers was very much shaken, so after a short consultation it was decided to take the boiler out and replace it with another one as we were badly in need of the steam.

In my opinion welded patches on a boiler are not only bad practice, but very dangerous and should be prohibited by law. Welding by oxyacetylene has a tendency to increase the amount of carbon in the weld. This causes an increase in the brittleness of the metal and a decrease of its tensile strength. With great changes of temperature as are present in a steam boiler, these welds are sure to give way sooner or later.

Shamrock, Okla. H. T. SMITH.

Why Are Ammonia Fittings Not Standardized?

Why are not ammonia fittings standardized? This is a question that not a few ammonia men have discussed. Take, for instance, the engineer in charge of an ammonia plant who is in charge also of the repair and upkeep. He may want to make some changes in the plant for various reasons. This change involves several fittings, including valves and flanges of any given size. He may have some of these fittings of a certain make in stock, and when he comes to use them he finds they are of a different make from the ones he removed or the flanges are not going to fit the flanges on the pipe ends. This results in a bill for new fittings and consequently increases his operating expenses materially.

Again, a man may want to install a new piece of apparatus in the ammonia plant and he finds he must take out a lot of perfectly good piping and flanges and replace them with the companion fittings of the new piece of machinery. This also runs up the expense.

Standardization, in my opinion, would overcome a lot of favoritism and prejudice on all sides and tend to promote sales of this particular line of equipment. A great many fittings such as valves are sold with companion flanges, but even so, it takes a little more time to remove the old flanges from the line and place the new ones on, whereas, if the fittings were standardized, we could remove the old valve and put in the new one and have the line back in service much quicker.

It might be of interest to hear from other engineers and erecting men on this subject. R. G. SUMMERS.

Rochester, N. Y.

Unloading and Placing a Nine-Thousand-Square Foot Condenser

Not infrequently, operating engineers are called upon to remove old machines and replace them with new units or make an initial installation of a particular machine. Generally, the smaller the plant is, the more limited the facilities for doing work of this kind and

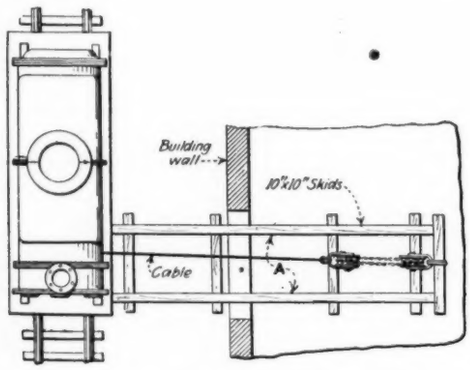


Fig. 1—Condenser was unloaded on skids placed at right angles to car

the more difficult the job becomes. Local conditions often determine the method of handling a job.

I recently had occasion to take charge of an erection job at a power plant where the facilities for handling equipment were somewhat limited. The track on which the cars were placed for unloading ran parallel to one side of the building and about eight feet away. When the plant was built, an unloading platform had been constructed immediately inside the door and level

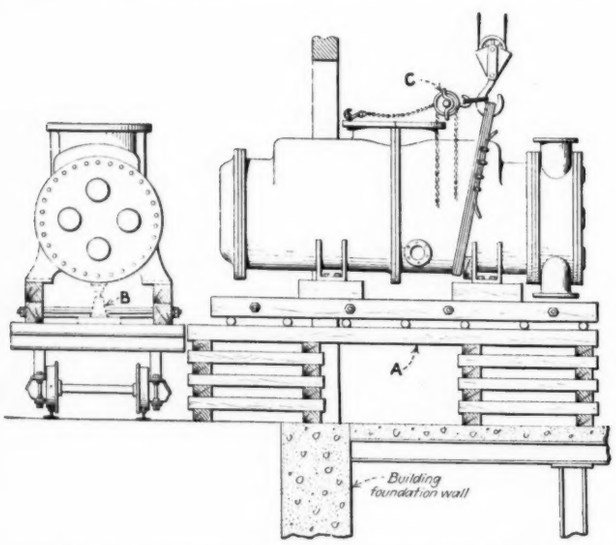


Fig. 2—Condenser on skids ready for slinging

with the operating floor of the turbine room, which was about twenty feet above the basement floor. Between the unloading platform and the foundation on which the machine was to be placed, a distance of about 75 ft., no operating floor had been laid. This open space necessitated carrying all the parts with the crane (which was operated by hand) to the foundation.

Before the work of unloading could be started, it was necessary to build up two tiers of railroad ties and obtain two 10x10-in. skids *A*, on which to roll the parts of the machines inside the door of the building, where they could be reached with the crane.

Figs. 1 and 2 show the first steps in unloading the condenser. When the skids had been put in place, the car was pushed back until the end of the condenser was about even with the skids. A screw jack was then placed under the ends (one at a time) as at *B*, and the condenser raised until rollers could be inserted under the skids to which it was fastened. To assist in turning the condenser on the car, a chain hoist was hitched between the ends of the skids and the condenser, as shown in Fig. 1. As the condenser was rolled inward on the skids, the car was pushed gradually forward

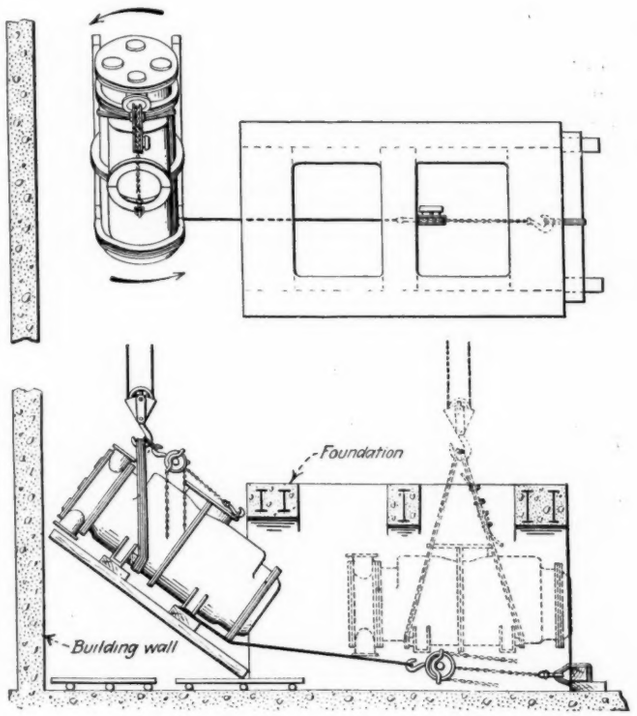


Fig. 3—Method of placing condenser under foundation

until the condenser was parallel with the skids and could be rolled in to the end of the platform.

The method of slinging the condenser on the crane, as shown in Fig. 2, may at first appear unusual, but by referring to Fig. 3 it will be readily seen why this was necessary. The foundation had been placed fairly close to the building wall, and in order to get the condenser in, it had to be tipped at an angle of about 45 deg. and swung around between the foundation and the wall, as indicated by the arrows. As the condenser was lowered to the floor and turned into place below the foundation, the skids were made to rest on heavy planks placed on rollers. With the aid of a chain block hitched to a timber placed across the end of the foundation, the condenser was drawn into place. A final hitch was then taken with the crane, as shown by the dotted lines in Fig. 3, and the condenser lifted to its proper location and timbers placed under each end, the feet being left free to permit the construction of the concrete pillars on which the machine was to rest.

H. W. PRICE.

St. Louis, Mo.

Comments from Readers

Reading vs. Filing

The "Foreword" in the Sept. 23 issue, entitled "Reading vs. Filing," was read with interest. We all know men addicted to the filing habit. In fact, some years ago I had it badly myself, and I well remember how proud I was of the great store of information I had stowed away, which would be on tap at the psychological moment to swamp all rivals, but somehow I never realized expectations. Often I knew I had the information required, but laying my hands upon it was another matter. I soon found the filing business a one man's job, and until I could see my way of paying someone to do it for me, it was better left alone.

This state of affairs was brought about after an all night search for a certain article which had appeared in *Power* some weeks previously. The general manager of the concern I was with had been discussing certain alterations, and I had mentioned that I had something similar fully explained. Naturally, he asked me to bring it along in the morning, which had to be done even at the loss of a night's sleep and, I may say, the loss of my filing system. I realized that, had I left the article alone, I could have found what I wanted in a few minutes by referring to the index. It is now some years since I cut or filed any articles from mechanical journals.

Some time ago I noticed the statement that no one who is holding down a man's job has time to read every article in *Power*. This I am sure is not in accordance with the views of many readers. I spend from four to six hours weekly over my copy, and anything new in the advertising pages is also studied, after which the paper is laid aside until a volume is complete, when a cheap binding is obtained. Should I have occasion to refer back, anything I require is easily found.

For many years reading has been to me a delightful recreation; to some, maybe, it is hard work, but I have yet to see the "man's job" where there is no time to read. The careful study of technical journals is a necessity to every man in the power plant, and the man who can make this a hobby will have no use for filing systems, but will be right up to date at all times.

Belfast, Ireland. F. P. TERRY.

The Protection of Pressure Gages

The article by Mr. Booker in the Sept. 9 issue on the "Protection of Pressure Gages," shows some practical methods for increasing the life of pressure gages, and I agree with him that they are too frequently regarded as useful attachments immune from damage or trouble.

Undoubtedly, the most common cause of a gage's becoming worn or failing to read correctly is vibration of the pointer, which may be caused by vibration of the machine to which it is attached or to a fluctuating pressure. If caused by operation of the machine to which the gage is attached, the best solution is to move the gage to some convenient place on the wall and connect it to the machine through small piping or copper tubing. When the vibration of the pointer is caused by a pulsating pressure, the general practice is to close partly the stop cock under the gage. Restricting the opening in this manner will in most cases stop the vibration of the pointer, but the extremely small opening is in danger of being entirely closed by a small particle of foreign matter and thus render the gage inoperative. In many installations, however, it is absolutely essential that the gages read correctly at all times, in which case it is not advisable to restrict the opening by closing the cock.

Some time ago one of our gages connected directly to the discharge of a pump became badly worn from vibration and had to be replaced with a new one. As considerable trouble had been experienced in keeping the old gage cock clear owing to its being partly closed to prevent vibration of the pointer, it was decided to place the gage a short distance from the pump and make provision in the connection for smoothing out the pulsation so that the cock at the gage could be left wide open. To accomplish this, a small chamber made from a short piece of 4-in. pipe with a cap on each end was placed below the gage, the lower end of the chamber being connected to the pump by a $\frac{1}{4}$-in. pipe.

To provide some restriction to lessen the pulsations, a diaphragm of sheet brass having a $\frac{3}{32}$-in. hole in the center was clamped in a union placed at a convenient point in the line. By using the chamber and the diaphragm, the desired dampening was obtained with a large opening, less likely to choke up. This allowed the gage to stand steady and will undoubtedly increase its length of service materially.

Providence, R. I. A. R. WILLIAMS.

Fitting Piston Rings by Peening

The article by Mr. Cowles in the Oct. 21 issue brings up an old and much discussed subject. As with many other engineering problems there is no fixed solution; the conditions under which rings may work vary widely, and variations are necessary for improvement.

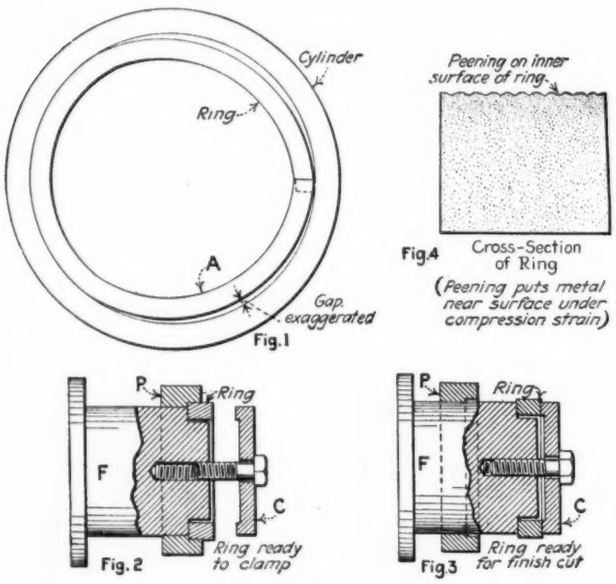
For large cylinders in steam-engine practice the sectional ring with fitted keepers at the joints and adjustable springs, coiled or lever, with which the pressure against the cylinder wall can be adjusted, has given excellent satisfaction. Of course this is much more expensive than the snap ring, but it would seem that money spent in properly fitting piston rings is well invested. I recall an instance in connection with a cross-compound engine on which we were making some tests where the low-pressure cylinder and valves were tight, but the high-pressure cylinder and valves were leaky. The opinion was offered by one engineer that the high-pressure leakage would not affect the results much, because the leakage was caught by the low-pressure cylinder. But it made considerable difference in

the steam consumption when we got the high-pressure piston and valves steamtight. It was well worth while to the purchaser.

For small cylinders the snap ring will probably be used for a long time to come. When a snap ring is turned to a circle larger than the cylinder bore and sprung into place, it takes a shape like Fig. 1, which is exaggerated. Where no other means are available, the ring is usually spotted and filed to a fit, but that is a long and tedious process. I do not understand how Mr. Cowles would peen a ring like that to fit, because at point *A* it would have to be peened on the outside. Evidently, his method applies only to rings that are too small in curvature or have "lost their tension."

The exact curves inside and out, to which a ring should be turned or milled so that when sprung into a smaller diameter it would give about equal pressure all around on the cylinder walls, is a matter of complex mathematics but of no particular value, because probably no one would build a machine that would do it automatically. The cost is too great. The eccentrically bored ring is a near enough approximation, and the following is a successful method used by one manufacturer for machining new piston rings to fit the cylinder bore.

In Fig. 2 is shown a fixture that can be mounted in an ordinary lathe. The movable piece *P* is a close sliding fit on the fixture. The ring, oversize in the rough, is sprung into the ring *P* and secured by the clamp *C*. The piece *P* is moved over as in Fig. 3 and the finish



Figs. 1 to 4—Methods used in fitting snap ring

cut to exact cylinder bore (within working limits) is taken. The ring will then fit the cylinder bore.

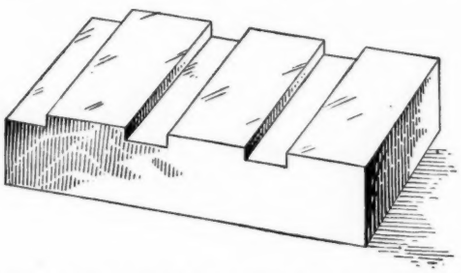
In my experience I have not had much luck peening rings that had lost their tension. In the first place they do not lose their tension without cause. A shoulder (which may develop even though the cylinder is counterbored) will cause that condition; also, poor lubrication, which causes the rings to overheat, will cause them to relax. In my opinion peening sets up a stress in a small area of metal near the surface, which is certainly not so good as having the stress distributed over the entire cross-section of the ring.

Toledo, Ohio. J. R. BELKNAP.

Erection of Turbines

The article by Claude C. Browne in the Oct. 21 issue will be found useful by all interested in the erection and running of steam turbines. Mr. Browne deals with small impulse turbines, and the following notes, drawn from my experience with reaction turbines, may be of interest.

The practice of leveling and supporting bedplates with wedges, even though closely spaced, is not good,



Type of packing block used between bedplate and steel girder

and is condemned by at least one well-known manufacturer. That wedges could move in a bed of grout would appear impossible, but the author has seen this occur with bad vibration and a hot bearing resulting. Some traces of movement can often be detected when removing the bedplates of an old machine from its foundation. The natural tendency of a wedge to slip out is aided by vibration (these remarks do not apply, of course, to wedges of special design), and movement, with consequent straining, may take place. The better, though more troublesome practice, is to support the bedplate on parallel packing pieces. To make sure that each packing piece is taking its proper share of the load, it is only necessary to "sound" with a hand hammer before grouting. The grooving of the foundation top to give a firm hold to the grout seems good practice. This could be done before the concrete is hard, and it should prove cheaper than the usual method of roughing with a mason's chisel.

It is usually best to delay grouting as long as conveniently possible. The full weight of the machine should be on the bedplate so that if any springing or settling occurs the packing may be adjusted. Bedplates and large cylinders that have stood improperly supported for considerable time, will warp, sometimes to the extent of having to be re-machined. This warping may not be discovered until the erection is nearly completed. When grouting small auxiliary machinery a quick-hardening cement, often used by marine engineers, is made by adding a few handfuls of silicate of soda to a bucket of cement mixed with warm water. If any part of the bedplate has to be supported on a girder, cast-iron packing pieces must be used; it is not easy to obtain a good fit, but the form shown in the sketch has been used with success.

If the turbine has been properly fitted and shipped, no gasket should be necessary between the cylinder faces. This would be impossible on large units or on the old type of tip-clearance reaction turbine. A smearing of graphite should be sufficient. As some manufacturers are now grinding the cylinder faces, good joints are easier to make. If the faces are not true, the old method of marking and filing must be employed.

In the modern reaction turbine with "end-tightening"

blading the axial shroud clearance is of first importance in securing thermal efficiency. The clearance is adjusted by shims in the thrust block. These shims are usually flooded with oil when running, and in the preliminary setting they should be placed in position well oiled, otherwise an error of some thousandths of an inch may be introduced. Final settings should, of course, always be made with the turbine hot. The feeler gage used should be tested with a micrometer; in old gages a 50 per cent error sometimes exists.

A good many turbine troubles can be avoided by cleanliness. Allow no cotton waste on the job, using old sweat rags and rubbing down all machined faces with the naked hand. Before putting the unit in operation for the first time, run the auxiliary oil pump several hours before starting, cleaning and washing the strainer periodically. It is advisable to warm the machine gradually for three or four days before the first run and then start with the generator uncoupled and exhausting to atmosphere. The engineers can then give all their attention to the one unit.

Montreal, Quebec. B. M. THORNTON.

[The use of silicate of soda in grout, as mentioned in the foregoing article, has been resorted to in some cases to make the grout set more quickly or to lower the freezing point, but it is not generally considered good practice.—Editor.]

Boilers for Heating Purposes

The fallacy of installing low-pressure boilers in large buildings for heating purposes is, in my opinion, the outstanding blunder of modern engineering practice and thought. I read with interest the editorial in the Oct. 28 issue of *Power* touching on this subject, and also on the practice so prevalent among the architects in specifying this sort of equipment.

The architects in many cases have inflicted upon us some fearful and wonderful engineering along steam-boiler lines. In matters pertaining to mechanical and heating equipment many of the architects' specifications savor strongly of some direct connection with manufacturers whose equipment is so frequently specified outright to the exclusion of all others.

In steam-boiler practice it not infrequently occurs that low-pressure boiler installations are made which cost more than the same steaming capacity could be provided for with first-class high-pressure apparatus. I have in mind a large manufacturing building in one of our large cities where a battery of 18 low-pressure firebox boilers were installed to heat the establishment.

A first-class high-pressure plant could have been installed in this building easily for 50 per cent less money that this low-pressure installation cost. This plant was constructed within the last six years, so it cannot be blamed to lack of knowledge on recent developments in good boiler practice. Nor can it be credited to a small concern, that may not have known any better, for it is in one of the largest manufacturing concerns in the country in its particular line. Furthermore, the company has within its organization many men trained along mechanical-engineering lines.

I recently made an investigation in a small hotel of about a hundred rooms, and there I found a low-pressure boiler plant, with a total of 1,250 sq.ft. of heating surface. In this small plant four boiler units were installed of three different sizes.

I know of a large hotel of comparatively recent construction, with more than 1,000 rooms, which has in it a boiler plant of 20,000 sq.ft. of heating surface in five 4,000-sq.ft. units. In this hotel two 4,000-sq.ft. boilers handle the house easily and the remaining power is not required at all. Allowing one 4,000-sq.ft. unit as spare or emergency equipment, there then remains 8,000 sq.ft., or 40 per cent of the entire original boiler plant, which is not required. Such examples as these are no credit to either the profession of architects or the science of engineering, and cannot be considered the best thought along the line of economics in building construction.

The additional cost for a nominal increase in pressure in a boiler plant of moderate working pressure is very small. Take for example a 72-in. by 18-ft. standard horizontal return-tubular boiler. If one is built for 100 lb. and another for 150 lb. working pressure, there is a difference in weight for the higher-pressure vessel of about 1,500 lb. First-class tubular boilers can be purchased today for less than ten cents a pound, so that for a pressure increase of 50 per cent above 100 lb. the net increased cost for a 1,500-sq.ft. boiler for the higher pressure would be less than $150.

Obviously, the foundations, brickwork, grates, breeching and suspension steelwork will cost no more for the high-pressure than it will for the low-pressure boiler. And similarly, the smokestack will not be changed in dimensions, nor will the rigging and erecting cost be influenced in the slightest degree by the difference in pressure, and up to 150 lb. saturated steam the piping cost should not be any more.

But the prize blunder of all I recently found in a new, first-class, large apartment hotel, in which was provided a laundry that required high-pressure steam for the flat-work ironer, also for the kitchen steamers. Here, three boilers were installed, each having about 1,500 sq.ft. of heating surface. All were of the firebox fire-tube type. Two units were built for a maximum pressure of 15 lb. and the third for 100 lb. pressure. They were all set side by side, and were located about 150 ft. from where the coal entered the building, and also where the ashes have to leave it.

A high-pressure heater was installed for heating the hot water for the house, so that this service and the laundry and kitchen services are dependent on the so-called high-pressure boiler the year around with nothing in reserve. The two low-pressure boilers are used to heat the building eight months in the year. The boiler that has to operate continuously throughout the year is the high-pressure one, but the ones for heating the house part time are duplicates. Of course electrically driven pumps are installed and the heating fans on the indirect hot-blast coils are also motor driven.

I examined this plant about three years ago, soon after it was built, as the owner wanted to install an electric generating plant. However, when he found out it would require a new boiler plant, which would be suitable for reasonable working pressure, he changed his mind. Had the boiler plant in this institution been of suitable design for the operation of a good prime mover, the savings that could have been accomplished by generating electric light and power would pay for the generating plant in less than three years.

There should be more work done along the lines of your editorial to the end that this low-pressure matter will be better understood by the business man and the investing public. EGBERT DOUGLAS,

Milwaukee, Wis. Consulting Engineer.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Water Column Connections

What size of pipe connections should be used for the water column of a return-tubular boiler, and what outlets may be placed on the pipe connections or water column or connections in addition to gage cocks and water glass? *J. A. B.*

The pipes connecting the water column with the boiler should be at least 1 in. The steam connection should be taken from the top of the shell or the upper part of the head of the boiler; the water connection should be taken not less than 6 in. below the center line of the shell. The water connection to the water column should be of brass and provided with necessary plugged crosses or plugged tees to facilitate cleaning of the connections. Either the water column or the water connection should be fitted with a drain cock or valve and suitable connections at least ¾ in. for waste to the ashpit or other safe point of discharge. In addition to this blowoff connection and connections for gage cocks and glass gage, there should be no other outlets on the pipe connections of the water column or water column itself except for damper regulator, feed-water regulator and steam gage.

Testing Motor Field Coils

Why is it not safe to test the heating of motor field coils by leaving these coils connected to the line with the armature standing still, or removed from the machine? *C. A. A.*

It is not necessarily true that leaving the motor field coils connected to the line is dangerous to the insulation when the armature is not running. In some elevator installations the shunt-field coils are connected directly to the line, while in others these coils are connected to the line through a resistance when the motor is standing still. When the motor is being started, the resistance is cut out of the shunt-field circuit.

When the armature is at standstill and the field coils energized, the heat from these coils must be carried off largely by conduction, particularly if the motor is in still air. Since air is a poor conductor of heat, the temperature of the coils will be much higher than when the armature is running as this will cause a circulation of air through the motor and about the field coils. When the motor is in service, the temperature of the armature is also increased, which increases the temperature of the air passing through the motor. However, even with this condition existing, the heat will be carried away from the field coils faster with the air circulating about them than it will be with the coils in practically still air, when the armature is not revolving. There are cases on record where motors operated satisfactorily with respect to temperature, but when the field coils were left connected to the line with the armature at rest, these coils roasted out in a few hours.

Napier's Formula for Flow of Steam

What is the source of the formula $W = P \times A \div 70$, where W is the weight of steam, in pounds, discharged per second from an aperture whose area in square inches is A; why is P taken as pounds per square inch absolute pressure; and how is the divisor 70 obtained? *C. S.*

The formula was proposed in the middle of the last century by S. D. Napier, an English engineer, as a result of carefully conducted experiments made by him in tests of the accuracy of formulas of steam flow that had been relied upon, but which he found to be in error.

Napier's tests convinced him that intricate formulas previously used when modified to the simple form, $W = (P \times A) \div 70$ would be more nearly true in cases where the initial pressure is 1¾ times the pressure of the gaseous medium into which the steam may be discharged. The formula has been extensively verified and is accepted as substantially correct for such conditions. In the formula, P is taken as the absolute pressure, since the physical properties of steam depend on the absolute pressure and not on the gage pressure, which is accidental, depending on the variable pressure of the atmosphere. The divisor 70 was recommended because for the conditions stated $P \times A$ was found to be 70 times the number of pounds of steam discharged per second.

Repair of Pitted Spot in Boiler Shell

In a shell plate of a boiler there is a place about one inch in diameter that is pitted to a depth of about one-half the thickness of the plate. How could the place be repaired, and would the working pressure have to be lower after the repair is made? *B. K.*

The method of making the repair would depend on whether the place would be exposed to the heat of the fire or furnace gases, and also on the condition of the surrounding plate material revealed after cutting out the bad spot. Above the fire line it would be sufficient to bore out the bad spot to receive a standard iron pipe screw plug, provided sound material is found for tapping good screw threads in conformity with the requirements of threaded openings of boilers. For a 1- or a 1¼-in. iron pipe plug, 11½ screw threads per inch, the minimum number of complete threads would be 4, requiring a 0.348-in. minimum thickness of boiler plate. For a 1½- or 2-in. iron pipe plug, 11½ screw threads per inch, the minimum number of com-

plete threads allowable would be 5, requiring a thickness of 0.435 in. of sound plate material. If a larger opening has to be made for obtaining good material of sufficient thickness, the hole should be covered with a riveted patch, which may be placed on the outside of the boiler provided the patch comes above the highest water line; otherwise it should be placed on the inside of the shell. After repairs the working pressure for the boiler will not need to be reduced if the opening is properly located to receive a screw plug in conformity with standard requirements, nor if a riveted patch is employed, as it should be suitable for as high a safe working pressure as the rest of the boiler shell.

Air Supply per Ton of Coal Burned

What quantity of air must be supplied for burning a ton of coal? *R. L. D.*

For complete combustion most fuels require between 11 and 12 pounds of air per pound of fuel, depending on the analysis of the fuel, and it usually is considered that for complete combustion 12 pounds of air are required per pound of fuel. But to make sure that each atom of carbon and other combustible will meet with an abundance of oxygen, it is necessary to admit more air to the furnace, the amount depending on the force of the draft. For best results with natural draft, about twice the theoretical quantity is required and with forced draft about 1½ times the theoretical quantity. A pound of air at 62 deg. F. has a volume of 13.14 cu.ft., so that for burning a ton of coal with natural draft the capacity for air supply should be about $12 \times 2 \times 13.14 \times 2{,}000 =$ 630,720 cu.ft. and with forced draft about $12 \times 1\frac{1}{2} \times 13.14 \times 2{,}000 =$ 473,040 cu.ft.

Butt and Double-Strap Joint, Double-Riveted

What would be the efficiency of a butt and double-strap joint, double-riveted, where the tensile strength of plant is 55,000 lb., the thickness of plate $\frac{7}{16}$ *in., the thickness of butt straps* $\frac{3}{8}$ *in., the pitch of rivets in the outer row* $5\frac{1}{4}$ *in., and the diameter of rivet holes* $\frac{15}{16}$ *in. with rivets driven to fill holes?* *A. S. M.*

The efficiency of the joint would be the least strength of a unit of pitch P indicated in the figure, divided by the strength of an equal length of solid plate.

If the tensile strength of the plate is 55,000 lb. per sq.in. of cross-section and the thickness of the plate is $\frac{7}{16} = 0.4375$ in., then

(1) The strength of solid plate per unit of pitch $P =$ $5\frac{1}{4}$ in., would be

$$5.25 \times 0.4375 \times 55{,}000 = 126{,}328 \text{ lb.}$$

Having the thickness of butt straps $\frac{3}{8} = 0.375$ in., diameter of rivets $\frac{15}{16} = 0.9375$ in. giving cross-section of rivets $= 0.9375 \times 0.9375 \times 0.9375 \times 0.7854 =$ 0.69 sq.in., and allowing strength of a rivet in single shear = 44,000 lb. per sq.in. of cross-section, strength of a rivet in double shear = 88,000 lb. per sq.in. of cross-section, and crushing strength of material = 95,000 lb. per sq.in., the strength of the joint per unit of pitch P would depend on the least value obtained from the following considerations:

(2) Strength of plate between rivet holes in the outer rows =

$$(5.25 - 0.9375)\ 0.4375 \times 55{,}000 = 103{,}770 \text{ lb.}$$

(3) Shearing strength of two rivets in double shear, plus the shearing strength of one rivet in single shear =

$$2 \times 88{,}000 \times 0.69 + 1 \times 44{,}000 \times 0.69 = 151{,}800 \text{ lb.}$$

(4) Strength of plate between two rivets in the second row, plus the shearing strength of one rivet in the outer row =

$$[(5.25 - (2 \times 0.9375)]\ 0.4375 \times 55{,}000 + 1 \times 44{,}000 \times 0.69 = 111{,}571 \text{ lb.}$$

(5) Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row =

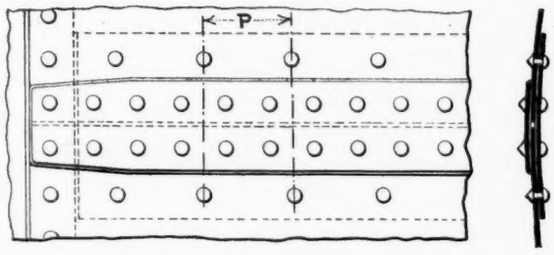
$$[5.25 - (2 \times 0.9375)]\ 0.4375 \times 55{,}000 + 0.9375 \times 0.375 \times 95{,}000 = 114{,}609 \text{ lb.}$$

(6) Crushing strength of plate in front of two rivets, plus the crushing strength of butt strap in front of one rivet =

$$2 \times 0.9375 \times 0.4375 \times 95{,}000 + 1 \times 0.9375 \times 0.375 \times 95{,}000 = 111{,}328 \text{ lb.}$$

(7) Crushing strength of plate in front of two rivets, plus the shearing strength of one rivet in single shear =

$$2 \times 0.9375 \times 0.4375 \times 95{,}000 + 1 \times 44{,}000 \times 0.69 = 108{,}290 \text{ lb.}$$



Butt and double strap joint double riveted

(8) Strength of butt straps between rivet holes in the inner row =

$$[5.25 - (2 \times 0.9375)] \times 2 \times 0.375 \times 55{,}000 = 139{,}219 \text{ lb.}$$

The least strength would be obtained from consideration (2), namely, 103,770 lb. per unit of pitch and the efficiency of the joint would be result (2) divided by result (1), or $103{,}770 \div 126{,}328 = 0.821$, or 82.1 per cent.

Reduction of Baumé Reading to Pounds of Oil Per Gallon

Knowing the Baumé reading of a fuel oil or distillate, how are the pounds per gallon estimated? C. M.

The weight per gallon will be equal to the weight of a gallon of pure water multiplied by the specific gravity or weight of the oil as compared with the weight of an equal volume of pure water. One U. S. gallon of pure water at the temperature of 62 deg. F. weighs 8.3356 lb. and one Imp. gallon of pure water at the same temperature weighs 10 lb. To convert degrees Baumé to specific gravity, the following formulas are used:

For liquids heavier than water, sp.gr. $= 145 \div$ (145 — deg. Bé.).

For liquids lighter than water, sp.gr. $= 140 \div$ (130 + deg. Bé.).

Hence for an oil lighter than water, if the reading per the Baumé hydrometer is 21 deg. Bé. the specific gravity would be $140 \div (130 + 21$ deg. Bé.$) = 0.927$, and the weight would be $8.3356 \times 0.927 = 7.727$ lb. per U. S. gallon.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

What Is a B.t.u. Worth?

IT is obvious that the cost of a heat unit in coal varies with the locality. If a given grade of coal costs two dollars a ton in one locality and ten in another—to take extreme cases—each B.t.u. in the second locality is worth five times as much as in the first.

But great as is the cost variation of the fuel B.t.u. from one locality to another, the variations corresponding to the form or condition of the energy are much greater. Anything that increases the usability of energy—that is, anything that puts it into a more refined and convenient form—invariably increases the cost. Energy at the plant is worth more than energy at the mine. Energy in steam is worth more than energy in coal. Finally, energy in the highly refined electrical form is extremely costly in comparison with that in fuel. Yet it must be worth the difference for many purposes or it would not be so widely used.

A coal of 13,500 B.t.u., costing $2 per ton (2,000 lb.) at the mine, offers heat at the rate of 7.4 cents per million B.t.u. If the freight amounts to $3 per ton, the cost of heat in the coal tar at the power plant is $\frac{5}{2}$ as much or 18.5 cents.

To get this coal into the furnace requires labor for unloading cars, operating conveyors and for firing. To this must be added the cost of the power and labor consumed by the mechanical devices for handling plus interest, depreciation, upkeep and general overhead on all the coal-handling apparatus. Therefore heat costs more on the grate than it does in the yard.

To release this heat in the furnace involves further expense in labor and overhead charges on stokers, furnaces, forced-draft fans, auxiliary apparatus, etc. The transfer to heat in the steam brings in other operating and overhead costs for boiler-feed pumps, etc.

Cost of Steam Energy

For present purposes all boiler-room costs of every sort, whether direct expense or overhead, may be lumped together and divided by the millions of B.t.u. fired. Remembering that all the figures given are merely plausible assumptions to show the idea involved and are not intended for use in actual installations, this boiler-room expense may be taken as 10 cents, bringing the total cost to 28.5 cents per million B.t.u. fired.

Although this figure includes all costs up to the steam main leaving the boiler room, it is by no means the cost of a million B.t.u. in that main. That is much higher, on account of the boiler-room losses of heat. Assume that the over-all boiler-room efficiency is 70 per cent. That means that for every million B.t.u. fired only 700,000 are delivered by the boiler room. The whole 28.5 cents must be charged against this amount of heat, making the cost of one million B.t.u. delivered at this point $28.5 \div 0.7 = 40.7$ cents.

While the increase in cost up to this point from 7.4 cents at the mine has been marked, by far the greatest increase is yet to come. An efficient central station might turn 25 per cent of the heat in the steam into energy at the switchboard. Assuming this to be the case, the total cost through the boiler room would amount to $40.7 \div 0.25 = \$1.63$ per million B.t.u. at the switchboard. To get the grand total at the switchboard, this figure must be increased by the total operating and overhead cost of all the plant outside the boiler room per million B.t.u. delivered. Taking this charge as $1, the switchboard cost would be $\$1.63 + \$1 = \$2.63$.

In most cases the expenses and losses of distribution would bring the cost of energy at the customer's meter to more than double that at the plant switchboard, so that $6 per million B.t.u. might be a fair guess for the cost at this point.

Cost Increases 8,000 Per Cent

We have seen how by a succession of expenses and heat losses the cost of a million B.t.u. has risen from 7.4 cents at the mine to $6 at the customer's meter, an increase of 8,000 per cent. But this is not all. All the figures quoted are cost to the generating company. If the company is to stay in business, a profit must be added. With this profit added the customer might pay, say, $8 per million B.t.u. for electrical energy.

Since one million B.t.u. is equivalent to $1{,}000{,}000 \div 3{,}415 = 293$ kw.-hr., the price quoted reduces to $800 \div 293 = 2.73$ cents per kilowatt-hour, which is about in line with the wholesale price of current in some localities.

The cost per million B.t.u. at the company's switchboard amounted to $2.63 per million B.t.u. or 0.9 cents per kilowatt-hour. Assuming that the station has a good load factor and is well designed and operated, an isolated plant situated in the same district and obliged to purchase coal, machinery and labor in the same general market, could not reasonably expect to equal this figure if there was no use for the exhaust steam, since smaller plants of equal efficiency naturally cost more per unit of capacity and have larger running expenses per unit of output.

However, the isolated plant would not have to compete against the central station's switchboard cost, but against its selling price of 2.7 cents, which would be quite a different matter, allowing a wide margin for greater unit expense for labor and overhead and for lower plant efficiency.

With a plant of reasonable size, and particularly where there is use for a fair proportion of the exhaust steam, the isolated plant can fall far behind the central station in "kilowatt" efficiency and overhead charges and still show a financial saving over purchased current.

Take the case of a plant in a large hotel or office building. Assume that the plant runs non-condensing, blowing to waste all the exhaust steam in the summer, using all the exhaust steam for three winter months and using part of the exhaust steam for another three months. Assume also that coal delivered costs 50 per cent more than in the central station, that the boiler-room efficiency is only 60 per cent and the engine-room efficiency is 12 per cent if no credit is given for exhaust steam used. Assume also that the other overhead and operating charges per unit of output in each section of the plant are double those of the central station.

Heat in the coal delivered to the plant will cost $18.5 \times 1.5 = 27.8$ cents per million B.t.u. Since practically the same boiler capacity would have to be installed for heating if no power were generated, the boiler-room investment costs chargeable to power would be largely eliminated. The net labor charge might be somewhat greater than for the central station. Assume that these total 10 cents. The cost of one million B.t.u. in the steam would then be $(27.8 + 10) \div 0.60 = 63$ cents.

Cost Low in Winter

During three months of the year practically no heat would go to waste. Assuming no loss and a turbine-room operating and overhead cost of $2 per million B.t.u. at the switchboard, energy delivered to the switchboard during these three months would cost $\$2 + \$0.63 = \$2.63$ per million B.t.u.

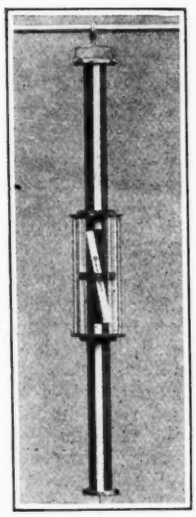
During another three months the wasted heat might be double that delivered to the switchboard, giving a switchboard cost of $(\$0.63 \times 3) + \$1.89 + \$2 = \$3.89$ per million B.t.u. Finally, during six warm months (with engine-room efficiency of 12 per cent) the cost at the switchboard would be $(\$0.63 \div 0.12) + \$2 = \$5.25 + \$2 = \$7.25$. The weighted average of these, according to the number of months, is $5.25 per million B.t.u. or 1.8 cents per kilowatt-hour, against 2.7 cents for purchased energy.

It should be noted that the foregoing data and assumptions are not given as typical for central-station and isolated-plant practice. Conditions vary so that such an attempt would be useless. It is only intended to illustrate energy cost by a hypothetical case.

New and Improved Equipment

Electrostatic Potential Indicator

To tell whether a high-voltage conductor is alive or not, the potential indicator shown in the figure has been developed. The principle embodied in this instrument is that the fall of potential along a tube of insulating material has, generally speaking, an even voltage gradient. That is to say, if 50,000 volts is applied to the ends of a tube 25 in. long, the fall of potential will be at the rate of 2,000 volts per inch of length. If a metal needle mounted on pivots is inserted in the center of the length of the tube and is inclined slightly toward one side, there will be an electrostatic attraction between each end of the needle and the axis of the tube, due to the difference of potential, tending to turn it parallel to the axis of the tube.



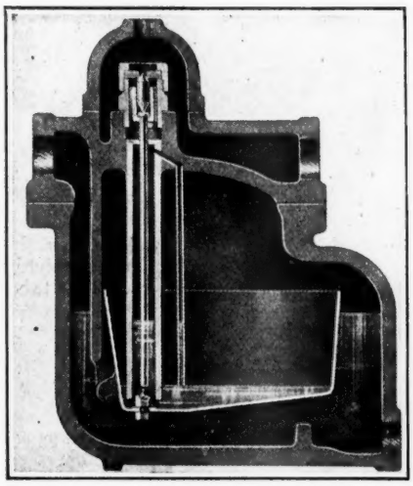
Potential Indicator

In the practical instrument based on the foregoing principle, a tube of special dark-colored insulating material is supplied, which has a broad white line along its outer side with an interruption in the center of its length, as indicated in the figure. At the center of the interrupted line is a bridge carrying a free-moving pivoted white aluminum strip, and a pointer, colored red, making a small angle to the axis of the tube, and inclosed in a concentric glass cylinder. At the ends of the tube terminals are provided for the connecting leads. If desired, however, a flange can be fitted at the lower end so that the instrument can be fixed in a vertical position, or a hook can be fitted at the upper end so that the apparatus can be hung on a high-potential conductor. The length of the tube varies in accordance with the maximum potential of the circuit.

The potential indicator is made in six standard sizes, covering a range up to 80,000 volts. The various sizes are arranged so that the working pressures for which they are suitable overlap to a certain extent. When in use, one end of the tube must be connected to the high-potential line and the other to "earth," and if the pressure is above minimum for registration on the particular instrument, the aluminum pointer will turn toward the axis of the tube. The instrument has been patented and is manufactured by Hartman & Braun, Frankfort, Germany.

Ellis "Red Head" Steam Trap

A bucket trap with a special air eliminator feature has been put out by the Ellis Drier Co., 1201 South Talman Ave., Chicago. As is usual in this type of trap, incoming condensation floats the bucket and closes the valve. Condensation continues to collect and eventually overflows into the bucket. As soon as a sufficient quantity has overflowed into the bucket to overcome the buoyancy, the bucket sinks and, in pulling the valve rod with it opens the valve. By the pressure within the trap the water is forced up through the discharge tube and out through the valve. Most of the water except that required for a seal is forced out of the bucket,



Section through Ellis bucket-type trap

and owing to its buoyancy the bucket again rises to close the valve. The discharge is thus intermittent with the valve fully open or closed.

The air eliminator is the feature distinguishing the trap from others. In the sectional view it will be seen that a small brass tube connects with the top of the discharge tube, the lower end extending close to the level of the water seal in the bucket. Its action may be explained as follows:

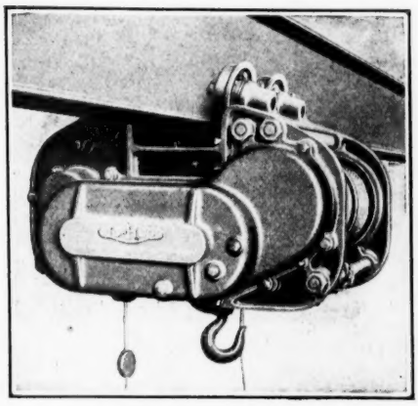
As soon as the trap has discharged its water and the valve is closed, the water in the discharge tube tending to drop back into the bucket creates a vacuum in the upper part of the tube. The lower end of the air eliminator tube is momentarily above the water level in the bucket, so that it breaks the vacuum in the discharge tube, allowing more of the water to return to the bucket. This falling action of the water causes a suction or siphoning effect which pulls the air up the eliminator tube into the space previously occupied by the water. As the water in the discharge tube falls, the level in the bucket rises until the end of the eliminator tube is sealed, thus locking the air in the discharge tube from which it is carried out with the next discharge of the trap. It is reported that this air-removal feature has been so successful in service that the trap is not equipped with an air cock.

Further reference to the illustration will show that both the inlet and the outlet of the trap are in the cover and that the valve cap gives access to the valve without disturbing the piping. A bronze locknut holds the valve and seat in place. Unscrewing this nut exposes both to full view. The valve and seat are made of monel metal and are reversible. The bronze cage holding the valve has guides cast on a spiral, which cause the cage to revolve when the trap is discharging, so that the valve is self-centering and regrinding. The discharge tube, which is made of heavy brass, is rolled to a tight fit into the cover. The bronze valve stem is secured to the valve cage by a collar upset from the solid metal. The connection between the valve stem and the bucket is a ball-and-socket joint to prevent binding from the tilting action of the bucket.

This trap is made for working pressures up to 250 lb. in eight different sizes with pipe connections from ¼ to 3 in. in diameter, and capacities to discharge 1,000 to 14,000 lb. of water per hour.

American Engineering "Lo Hed" Hoist

The American Engineering Co., Philadelphia, Pa., has recently added to its line a new "Lo Hed" electric-monorail



Electric monorail hoist

hoist as shown in the accompanying illustration.

The hoist is built in half-ton and one-ton capacities and is designed to operate in a small amount of headroom, it being possible to draw up the load block until it almost touches the rail. The complete unit is fitted with roller

bearings and is equipped with automatic lowering and holding brakes, also a limit stop that checks the hoist and throws off the current at the upper limit of travel.

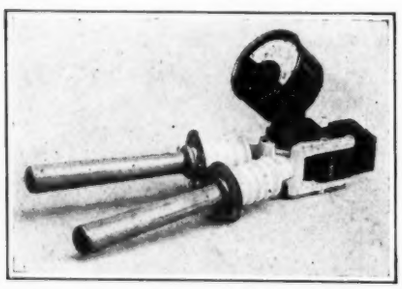
The hoists are furnished for either direct or alternating current and are designed to travel on standard I-beams around curves and through switches.

Current Tester for High- and Low-Voltage Circuits

The grip current tester shown in the figure has recently been constructed for use in connection with both low- and high-tension circuits, being applicable without any interruption of the line, and gives its indications on either an indicating or recording ammeter. The instrument enables measurements of current distribution in networks or through supply points to be made easily and at any time. In this way records can be obtained which enable the distributing system and transformers to be most economically loaded. The device can also be used for locating faults and leaks in distribution systems.

The apparatus consists essentially of a transformer with two cores of laminated soft iron, hinged together and provided with handles which, on being pressed, open the iron circuit, so that the conductor to be tested can be inserted into the core. On the core is wound a coil of insulated wire, which forms the secondary circuit of the transformer, with the conductor as the primary. A spring insures that the air gap between opening points of the core is negligible and constant. The secondary winding is connected to the indicating or recording apparatus, which will then indicate the current flowing in the primary conductor.

Transformers and generators connected in parallel often have insufficient ammeters to indicate if the current in each conductor is of the correct value, and it not infrequently happens



Current tester can be used without interrupting the circuit

that the division of the load at certain periods is incorrect. The tester enables measurements on each conductor to be made and the best working conditions secured.

Direct-current networks must have an intermittent, or alternating, current superimposed on the direct current if they are to be supervised with the same ease as alternating-current lines. The instrument has been patented and placed on the market by Hartmann & Braum, Frankfort, Germany.

New Pryko Steam Trap

Simplicity is a feature of a float-operated trap recently developed by the Pryko, Inc., 39 Cortlandt St., New York City.

A cross-section of the trap is shown in Fig. 1. The valve, which is submerged and water lubricated, is the only moving part. Referring to Fig. 2, it will be seen that the valve mechanism consists of one stationary and one movable member. The movable sleeve in which the valve seat is fastened is revolved by the action of the float and is moved back and forth by means of a cam working in a spiral groove.

In operation the pressure on the valve retards the float action until the

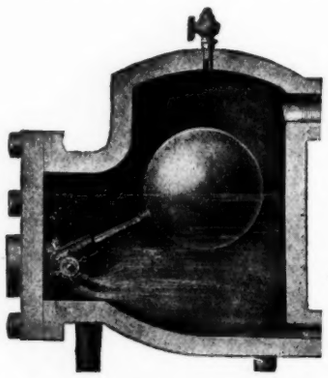


Fig. 1—Cross-section of trap

buoyancy of the float unbalances this pressure, then the valve opens quickly. On closing, the reverse action takes place, the pressure on the valve over-

Fig. 2—View of valve mechanism

comes the buoyancy of the float and the valve closes quickly. The valve, in closing, has a rotating motion, and this tends to give a self-grinding action on its seat. The valve and seat are of monel metal for high pressures and bronze for low pressures.

Bousman Oil Filter

A new oil filter, known as Type S, has been added to the general line of the Bousman Manufacturing Co., of Grand Rapids, Mich. The filter is of the continuous and batch types employing the up-filtration principle, in which the oil is filtered away from the dirt rather than through it. The general construction is shown in the figure.

Under float control from the clean-oil chamber at the top, dirty oil is fed by either a small pump or a gravity tank into a chamber at the bottom of the filter. Here the heavier suspended matter and the water settle and are drawn off as sludge. A heating coil is provided to facilitate the action should this be desirable. Owing to capillary attraction and pressure from the inlet, the oil passes up through 3 to 6 cu.ft. or more, according to the size required, of filtering materials to enter the clean-oil chamber at the top of the filter, from which it is drawn off as required.

Thorough filtration and relatively long

Section through Bousman Type S oil filter

intervals between cleaning and repacking periods are the advantages claimed for this equipment, based on the large amount of filtering material used and the fact that the water and much of the dirt are removed before these impurities get into the filtering medium.

For engine and ordinary lubricating oils the filter capacity is 25 gal. per hour and for gas-engine oils, 5 to 10 gal. per hour.

Chicago Museum Uses Weather Forecasts to Save Coal

Careful and constant observation of weather conditions by means of using United States weather forecasts is an important factor in the saving of $10,000 a year in fuel costs accomplished by the Field Museum of Natural History in Chicago. The amount of coal consumed has been reduced 2,000 tons below the minimum called for by the firm that originally installed the heating apparatus.

The Field Museum is located in an exposed, wind-swept position. Its 1,250,000 ft. of exhibition floor space is kept at a temperature between 60 and 67 deg. during visiting hours by means of 400 radiators. When the outside temperature raises the inside temperature above 67 deg. the heating plant is shut down.

Twenty-three thermometers are hung inside the building and one outside. One or more heating units can be shut off whenever a thermometer indicates rising temperature in a particular part of the building. The night watchman makes sure that the building does not get too cold when the plant is shut down after visiting hours. When a rise in temperature is predicted for the next day it is safe to allow the night temperature of the museum to drop farther than if a lower temperature is predicted.

Legal Aspects of Boiler Explosions

By A. L. H. Street

CONSIDERING the frequency with which juries have found owners of steam boilers to be negligent in failing to discover defects resulting in explosions, and that engineers have been negligent in managing boilers, an outsider might assume that both owners and engineers are sometimes inclined to take fiendish delight in the bursting of boilers. But it is gratifying to note that the assumption is not universal, for the opinion of the Kentucky Court of Appeals in the case of Branham's Administrator vs. Buckley, 166 Southwestern Reporter, 618, has this to say concerning a verdict exonerating defendants from liability for a fatal accident to a visitor in a grist mill power plant:

"The jury evidently felt some doubt as to the exact cause of the accident; and, having in mind the fact that there is a general disposition among men to preserve their property, and among operators of steam boilers to preserve their own lives, and that ordinarily these motives will secure that degree of care which the defendants were charged with under the law, the jury doubtless believed that the injuries to plaintiff's intestate were occasioned, not as plaintiff contends, by negligence of the defendants, but rather by one of those unfortunate casualties which ordinary care and prudence will not always prevent."

In that case it appeared that a boy went to the mill with corn to be ground. While waiting for the meal he went into the boiler room to warm himself, and was fatally injured through explosion of the boiler.

Plaintiff's Contention Overruled

The court overruled a contention made by the attorneys for the plaintiff, who sought an award of damages on account of the accident, that the mere fact that the boiler burst raised a presumption of negligence, making it incumbent upon defendants to prove that they had exercised the highest degree of care in operating the boiler and in maintaining it in safe condition. It was decided that, although defendants had invited the boy to warm himself by the boiler, the case was nevertheless governed by these rules:

"The owner or occupant of premises who induces others to come thereon by invitation, express or implied, owes them a duty of using reasonable or ordinary care to keep the premises in safe condition; but he is not an insurer of the safety of such persons. . . .

"And, where the defendant owes plaintiff no duty other than the exercise of ordinary care to prevent injury, the fact of an explosion of a steam boiler creates no presumption of negligence. 36 Cyc., 1265; Veith vs. Hope Salt Co., 51 W. Va., 96, 41 S. E., 187, 57 L. R. A., 410; Cosulich vs. Standard Oil Company, 122 N. Y., 118, 19 A. S. R., 475; Huff vs. Auston, 46 Ohio St., 386, 21 N. E., 864; 15 A. S. R., 613. . .

"Thomas Buckley, one of the defendants, testified that at the time the crown sheet gave way, the boiler was two-thirds full of water; that he was carrying only 95 lb. steam pressure; and that he did not know what caused the crown sheet to fail. The evidence for plaintiff tended to show that Buckley had permitted the boiler to become dry, and then started the injector, forcing cold water into the boiler and thereby causing it to burst. The evidence was conflicting; but we cannot say that the verdict [in favor of defendants] is flagrantly against the evidence."

It appears that the only theory on which the engineer could account for the explosion was that the bolts securing the crown sheet had "failed to be bradded good." However, the Court of Appeals decided that counsel for plaintiff had failed to properly preserve any right to recover on a theory of negligence on the part of the defendants in maintaining the boiler.

Another Case Cited

In the case of Corbett vs. Lymansville Company, 69 Atlantic Reporter, 69, the Rhode Island Supreme Court took a less favorable view of the right of the defendant in an action of this kind to immunity from liability until negligence is expressly proved. That court said:

"When it is shown that a machine adapted to retain steam under pressure is apparently in good condition and capable of withstanding an ordinary pressure, and suddenly explodes with violence, it is a fair inference that the explosion was caused by an extraordinary pressure from the steam supplied. If the explosion was from other causes, the means of ascertaining the fact were entirely within the power of the defendant."

Connecticut Supreme Court Decision

What the Connecticut Supreme Court of Errors has decided (Temple vs. Gilbert, 85 Atlantic Reporter, 380) concerning the liability of a locomotive engineer for injury to another caused by explosion of a boiler managed by him undoubtedly accurately applies to stationary engineers as well. Evidence for plaintiff tended to show that the explosion was due to defendant engineer's failure to keep sufficient water in the boiler. On the other hand, defendant's evidence tended to disprove that fact, and tended to show that, without his fault or knowledge, the boiler previously had been weakened, and that that caused the explosion. The court approved the following instructions given by the trial judge to the jury, whose verdict for $5,000 in plaintiff's favor was sustained:

"Negligence is the failure to use that degree of care for the protection of another that the ordinarily reasonably careful and prudent man would use under like circumstances. The defendant in this case was an engineer. So, as applied specifically to this case, negligence would be the failure on his part to use that degree of care and caution to keep the water at the proper point in the boiler, which the ordinarily careful and prudent engineer would use under those circumstances under which he was situated. The defendant is liable or not according as he came up, in the management of that engine, to the standard of care that the law imposes. Did he, in managing that engine at the time the explosion happened and at the time just prior to the time it happened, exercise that degree of care and caution that the ordinarily prudent and careful engineer, under similar circumstances, was bound to exercise?"

"Had that boiler before it was delivered into the hands of the engineer on that morning ever been overheated so as to weaken it, and was it delivered into his hands in that condition? . . . There is no testimony that he knew anything about this himself. It was a new engine to him. . . . He had a right to assume when he took that engine . . . that the boiler was in good and sound working order. He had the right to go ahead and handle that engine on the presumption that it was properly constructed and in proper repair."

Iron and Steel Electrical Engineers Discuss Metering Problems

On Saturday afternoon and evening, Nov. 8, the Philadelphia Section of the Association of Iron and Steel Electrical Engineers held its regular monthly meeting at Reading, Pa. In the afternoon members and their friends were given an opportunity to inspect the new meter department of the Metropolitan Edison Co. and to see how various types of meters were calibrated and adjusted, as well as the checking of transformers and other appurtenances. This meter department is one of the most complete in the country. Meters that it used to take one and a half hours to test can now be tested in about five minutes. The connecting of a single-phase watt-hour meter into circuit for testing has been reduced to hanging the meter on a screw in the test board. By this one operation all connections necessary for the test are made. By closing a double-throw switch to one position light load on the meter is obtained, and by closing the switch to the other position full load is applied, with the rotating standard watt-hour meter in circuit in both cases.

Testing Polyphase Meters

The testing of polyphase meters is carried out in much the same way except that provisions are made for testing each element separately or in opposition, simply by closing the proper switches. Although the State Public Service Laws allow an error of 2 per cent in the meter's accuracy, the Metropolitan Edison Co.'s practice is to adjust all meters to within one-half of one per cent. Where transformers are used with the meters, their ratios must be correct to within one per cent.

In the evening about 300 members and guests attended a dinner at the Hotel Berkshire, after which Horace B. Pratt, meter supervisor, Metropolitan Edison Co., presented a paper "Meas-

urement of Electricity," in which he gave a description of indicating, integrating and graphic meters and their application to the measurement of power and power factor in industrial plants.

After describing the various types of meters, Mr. Pratt went into the question of power-factor correction and pointed out that in addition to using up the capacity of generating and transmitting equipment for no useful purpose, low factor also was detrimental to the system's voltage regulation. One of the chief causes of low power factor was overmotoring. The speaker emphasized the use of graphic meters for studying power loads. These not only gave a graphic picture of the power load, but they would show many other things, such as defective machines, how machines are operated and when employees start and stop work, etc.

Instruments Should Be Handled With Care

Attention was called to the necessity of handling instruments carefully. Among the most common causes of injury to meters were, dropping them into their cases, placing them on benches subjected to vibration, being pulled off a bench by someone running into the leads, too small capacity instrument used for a given load and stray magnetic fields. When using meters, care should be taken to use the proper auxiliary apparatus with them such as shunts, current and potential transformers. When taking readings care should be exercised so that the proper multipliers are used.

In discussing the accuracy of watt-hours meters, it was brought out that on a monthly load of 2,600,000 kw.-hr. measured by two different meters, a difference of only 2,350 kw.-hr. was found. This amounted to a difference of only 0.09 per cent. Mr. Pratt said that his company had in use about 28,000 meters and an average of about one complaint per day was made as to meter accuracy. Tests have shown that about 5 per cent of the complaints were justified and 95 per cent of the meters tested on complaint were found correct.

Preventing Corrosion with Water Glass

Silicate of soda, which in the liquid form of "water glass" is familiar to the housewife as a means of preserving eggs, and to power-plant engineers as a heat-resisting adhesive and an ingredient of refractory cements, is now being used to protect pipes from corrosion. As those who have used water glass know, it dries out to a hard glass-like substance. Similarly, when silicate of soda, in either liquid or solid form, is added to the water passing through a pipe, a protective film is gradually built up on the inside of the pipe, which greatly reduces the corrosion. This effect has been recognized for a number of years, and there are on the market several proprietary compounds containing silicate of soda, with feeding apparatus by means of which the compounds may be introduced continuously into water lines. Perhaps the chief application of this system of corrosion prevention has been in domestic water lines, where deaërators cannot ordinarily be used on account of their cost.

During the last year or two, systematic experiments have been carried out to determine the value of this method of corrosion prevention. The results obtained were outlined by Frank N. Speller, metallurgical engineer with the National Tube Co., at the Detroit meeting of the American Electrochemical Society on October 2.

How Films Protect Metal Surfaces

Mr. Speller prefaced his remarks on the use of sodium silicate with a general discussion of film protection. He showed how natural protective coatings are sometimes formed. For example, under the same conditions of service a galvanized-iron hot-water pipe might last ten years on an average in New York City, twenty in Chicago and thirty in some other locality. The New York water, being exceptionally soft and pure, is not able to form a protective coating, except in so far as the rust itself is protective. Protection comes partly from the organic matter which forms a gelatinous film inside the pipe and partly from the scale-forming substances contained. Pipes using Great Lakes water rapidly accumulate scale but show little corrosion.

When exposed to the weather, some metals (such as zinc, aluminum, nickel and copper) form protective oxides that retard further corrosion. Iron carrying a small amount of copper, when exposed to the atmosphere in certain localities, forms a dense, hard layer of rust, which seems to have much to do with the relatively high resistance of copper-bearing iron to atmospheric corrosion. The remarkable condition of the Delhi iron pillar, erected 1,600 years ago in Hindustan, and which is today practically uncorroded, is probably due in large measure to the scale which was forged into the metal in the course of fabrication. The dry climate was a contributing factor.

Scale Protects Wrought Iron

Samples of old wrought-iron forged articles have been found in a good state of preservation. However, on filing off some of the scale, which was invariably found on the surface of these specimens, and exposing them to the weather, the underlying metal rusted rapidly at the exposed places.

It has been shown that the effect of alkalinity in retarding corrosion is due to the rapid formation of a protective layer of hydroxides of iron upon the metal surface. The initial rate of corrosion appears to be practically unaffected by the alkalinity.

Liquid sodium silicate has been employed as the basis of proprietary compounds for use in domestic hot-water systems to form a protective scale on the inside of pipe. When added to water in small quantities, this compound is usually broken up into silicon dioxide and sodium hydroxide. The former builds up a dense and adherent film.

Tests were made with Pittsburgh water at 110 deg. F., flowing through a clean black steel pipe, to compare the corrosion with raw water with that obtained when silicate was added. On an arbitrary scale the rate of corrosion dropped in seven days to a steady value of 380 with the raw water and in fourteen days to a steady value of 50 with the water containing silicate.

Research work done at the Mellon Institute and at the Massachusetts Institute of Technology, with the financial support of the National Tube Co., leads to the following conclusions:

1. Silicate of soda has a marked effect on the rate of corrosion of iron by hot water, and a distinct but smaller effect on corrosion by cold water. Other scale-forming substances help, although protective films are formed even in water of zero hardness.

2. The amount of silicate required is about fifteen parts per million for the first application. After a substantial protective film is formed, a concentration of from five to ten parts per million is usually sufficient to maintain the film in hot-water pipes.

3. The anhydrous (water-free) sodium silicate, having 3.25 parts of SiO_2 to one of Na_2O, is best for use with hot water, as it is less soluble than the more alkaline silicates of soda. In no case, however, will all the silicate be dissolved. Sodium silicate in solid form is preferable to liquid, because the supply requires refilling only every two to four months, where the liquid addition should be made every day or two. Automatic feed devices for liquid additions, where the rate of water consumption varies considerably in short intervals, have been found to be unreliable.

Limitations of Silicate Treatment

Where the cost is not prohibitive, it is naturally best to remove the cause of the trouble, which is usually the dissolved oxygen. The chief application of the silicate method seems to be in residence use. In hot-water systems the silica is deposited more densely near the source of supply and does not form a protective film much more than 100 to 200 ft. from point of application.

The addition of silicate to cold water reduces corrosion about 50 per cent (according to tests made in Cambridge, Mass.), whereas in hot water a film was built up in thirty days which gave a reduction in corrosion amounting to 80 per cent. However, the treatment will carry through a much greater pipe length with cold water. With cold water it is necessary to use the silicate in liquid form.

Attention is called to the fact that negotiations with the Federal Power Commission usually do not require the services of an attorney. Most of the transactions with the commission must be reduced to writing for matters of record, and delay results when this correspondence must be carried on through a representative of the party at interest. There have been recent instances in which persons with nothing more than routine business to transact have been of the opinion that it was necessary to employ a person on the ground for that purpose.

William H. Patchell Sails for England

Compared British and American Practice in Final Address at Brooklyn

ON NOVEMBER 8, after an extensive visit in this country, William H. Patchell, president of the Institution of Mechanical Engineers of Great Britain, embarked for England on the "Majestic." His stay in this country, which was partly devoted to a study of American practice in power production and distribution, was marked by many courtesies. He was present at the recent centennial celebrations of the Franklin Institute at Philadelphia and the Rensselaer Polytechnic Institute of Troy, New York. He visited many manufacturing concerns, including the General Electric Co.'s Schenectady plant and the Bayonne plant of the Babcock & Wilcox Co. He also renewed acquaintanceships with the designing and operating engineers of some of the larger power stations.

As one with a first-hand knowledge of the development of power in Great Britain during the last forty years and with a considerable knowledge of American plants gained on former trips to this country, Mr. Patchell is now uniquely equipped to compare power-engineering practices on two sides of the Atlantic.

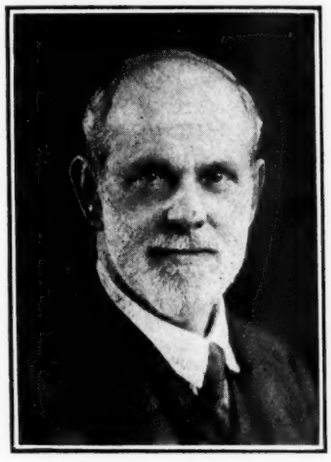
Mr. Patchell's last public appearance before sailing was on the evening of November 7 at a meeting of the technical section of the Brooklyn Edison Club. After he had made an address in which he compared the power developments of the last forty years in England and America, he was presented with several etchings of Brooklyn Edison properties made by Joseph Pennell, the well-known artist. The speech of presentation was made by M. S. Sloan, president of the Brooklyn Edison Company.

The following digest, based on notes made at the meeting, indicates the trend of Mr. Patchell's thought, but not the actual language used.

Forty Years of Engineering Progress

In 1886 I was appointed chief engineer of an electrical supply undertaking in the center of London. In this little area we had two competitors, so that in some parts of our district there were two and sometimes three sets of mains. The division of London, as well as the whole of England, into small districts each with one or more independent supplies of electricity, has caused much loss and confusion.

My experience with power-plant operation started in 1881 when I handled a simple Robey slide-valve engine at the Paris Exposition. This drove a 16-kw. generator, used saturated steam at 80 lb. pressure, and consumed 140 lb. per kw.-hr. It is interesting to follow the subsequent developments in size, steam pressures, steam temperatures and efficiency. In 1893 a Willans compound high-speed



William H. Patchell

engine at Maiden Lane, W.C., developed 100 kw. with a steam consumption of 31 lb. In 1901 at the Bow, E, Station a 1,600-kw. Sulzer compound horizontal slow-speed engine consumed 18.4 lb. per kilowatt-hour using saturated steam at 160 lb. pressure. This figure was slightly bettered by the 6,000-kw. Allis-Chalmers compound engines erected in the Fifty-ninth Street Interborough Station, New York City, in 1905.

In 1909 these engines were combined with vertical low-pressure turbines, the combination using only 13.7 lb. of steam per kilowatt-hour. In the modern plants in Detroit, Chicago, Berlin and elsewhere, with turbines of 25,000 kw. and up, the steam consumption per kilowatt-hour runs from 9.7 lb. to 11.3.

The development in boilers during the same period has been perhaps even more spectacular. The Robey locomotive boiler, exhibited at Paris in 1879, had 600 sq.ft. of heating surface, 86 cu.ft of combustion volume and carried a pressure of 80 lb.

The world's first large boiler was the Hornsby "Upright" installed at the Bow Station in 1903. It had 21,700 sq.ft. of heating surface and 5,356 cu.ft. of combustion space and was hand fired. This boiler gave the suggestion which led to the construction of similar large boilers in various Detroit plants. These were Stirling-type boilers.

North Tees was the first British high-pressure station, steam being used at 450 lb. and 650 deg. F. in marine-type cross-drum boilers. The Barrow boiler, formerly used almost exclusively for marine work, is being tried out in the Barking Station in London. The construction is quite different from that generally used in land plants. This boiler has a single upper drum and three lower drums, two on one side and one on the other, straight tubes connecting the upper and lower drums. The combustion space is "A" shaped and there are no baffles. In view of the excellent results obtained with this boiler, it seems that Stirling-type boilers might also work well without baffles.

While the present trend toward high pressures undoubtedly offers great possibilities, it seems to me that it is important to get around the present necessity of constructing the high-pressure boiler drums by forging. Such work lies far beyond the capacity of the ordinary boilermaker.

America consumes from 500 to 800 units (kilowatt-hours per year) per capita. The English consumption runs from 100 to 180 units, not because British stations are less efficient, but because the electrical industry in America has employed more aggressive salesmanship.

Machinery Manufacturers Not Represented in Washington

Government agencies dealing with matters pertaining to machinery would be pleased were the various associations of machinery manufacturers to arrange for representation in Washington. While most of the large industries maintain offices in Washington for purposes of contact with the federal government, machinery manufacturers do not provide such a facility.

Because of the need for closer contact with this industry, particularly in matters pertaining to the promotion of foreign trade, the hope is expressed that these organizations arrange for the maintenance of a liaison organization in Washington. The advantage to the federal agencies of having available for immediate consultation a man thoroughly acquainted with the current situation in the industries engaged in machinery manufacture, is considerable, but the thought is expressed that such an arrangement would carry with it much greater advantages to the industry itself.

Steinmetz Memorial Fund Established

A fund of $25,000 has been appropriated by the General Electric Co. for a memorial to Dr. Charles P. Steinmetz, who died a year ago, at Union College where Dr. Steinmetz was a professor. The income from this fund will be used to provide four scholarships annually. In bestowing these scholarships, preference will be given to scholars whose relatives are connected with the General Electric Co.

Shipping Board Awards Diesel Contracts

The first step toward modernizing a number of the war-time fleet of merchant vessels was taken by the Shipping Board when it adopted a resolution formally authorizing the installation of internal-combustion engines in eighteen of the government's cargo ships. In taking this action the board proceeded under authority conferred upon it by Congress on June 6, 1924, when a bill was passed empowering the board to use for this purpose $25,000,000 of its construction loan fund. The resolution passed by the board authorized the purchase of eighteen Diesel engines, thirteen of which are single-acting Diesels as follows:

Four 3,000-hp. Busch-Sulzer Diesel Engine Co.; four 2,800-hp. Cramps Ship & Engine Building Co.; three 2,700-hp. McIntosh & Seymour Corp.; two 2,900-hp. Pacific Diesel Engine Co.

For the purpose of developing a domestic Diesel industry and to secure such benefits of decreased costs, weights and space, as well as possibility of greater powers, which the double-acting principle appears to offer, the board has also authorized the purchase of the following double-acting engines:

One 2,700-hp. McIntosh & Seymour Co.; one 3,000-hp. Hooven, Owens Rentschler; one 3,000-hp. New London Ship & Engine Co.; two 2,900-hp. Worthington Pump & Machinery Co.

These 18 units aggregate 51,650 shaft horsepower and an outlay of approximately $4,350,000, of which amount about $3,250,000, or 75 per cent, represents the cost of the single-acting group. The double-acting type represents 22 per cent of the total power and the relative average costs are $87.50 and $76 per horsepower respectively.

Holtwood Steam Plant To Use Pulverized Fuel

The Pennsylvania Water & Power Co. has decided to use pulverized coal for firing boilers at its new steam plant at Holtwood, Pa., and a contract has been given to the Fuller-Lehigh Co. for a complete equipment for handling between 350 and 400 tons of coal per day. The new plant will adjoin the existing hydro plant of the company and will be tied in with lines serving the Consolidated Gas, Electric Light & Power Co., of Baltimore. It is expected that this plant, which will cost about $3,500,000, will be put into operation in the spring of 1925. The ultimate capacity of the plant is 100,000 kw. with an initial installation of 20,000 kilowatts.

New York State Water Power Affected by Election

An important result of the election in New York State is the clarifying of the situation in relation to development of state-owned water power. In 1921 and 1922 the Robinson Water Power Law was enacted under the administration of Governor Nathan L. Miller. This law in brief allowed the issuance of permits for development of state-owned water power to private corporations at such rental as might be fixed by the Water Power Commission and conferred upon the Public Service Commission authority to fix rates to be charged the public for electricity generated. It created a water power commission consisting of the conservation commissioner, the attorney-general, the state engineer and surveyor, the temporary president of the Senate and the Speaker of the Assembly.

Due to political exigencies the Commission was obliged to function under a law with which it was not in sympathy. As a result all applications for power development pending before the commission were side-tracked.

After Jan. 1, 1925 the personnel of the Water Power Commission will be completely Republican and will probably be able to function under the provisions of the Robinson law.

While the Republican party has the majority in both branches of the legislature, it has not the two-thirds majority necessary to pass legislation over the veto of the Governor, and it is therefore extremely unlikely that any of the water power legislation providing for state development along the lines suggested in 1924 will prevail.

Federal officials are of the opinion, it is stated, that the re-election of Governor Smith means that water-power development in New York will be stalled for another four years. They admit, however, that this probably will interfere with no great amount of development since little higher-cost water power is likely to be developed while the St. Lawrence project is pending.

Human Factor in Industry To Be Studied

To study the human factor and to promote happiness, efficiency and productivity among the workers, science and business have united in a nation-wide investigation enlisting twenty agencies from medicine to organized labor, it is announced by Alfred D. Flinn, director of the Engineering Foundation.

The inquiry will be headed by the Personnel Research Federation established under the auspices of the Foundation and the National Research Council, and of which Dr. W. V. Bingham, of the Carnegie Institute of Technology, Pittsburgh, has, it is also announced, just been appointed director. Professor Bingham will establish headquarters at the offices of the Foundation, 29 West 39th St., New York City.

"Workers and their work," said Mr. Flinn, who is secretary of the Federation, "will be the object of science's newest attack on a species of ignorance which, it is believed, has hindered the progress of the race."

Luncheon given in honor of Dr. S. Z. de Ferranti, British engineer, on Nov. 6, by engineering societies

Production of Petroleum During September

Production of crude petroleum in September amounted to 59,635,000 bbl. as against 61,704,000 bbl. in the preceding month and 65,306,000 bbl. in September, 1923. Tank-farm and pipe-line holdings of crude petroleum as of Sept. 30 aggregated 363,700,000 bbl. as compared with 362,985,000 at the end of August and 314,493,000 a year ago. Refiners' stocks of crude at the end of September amounted to 41,549,000 bbl. which compares with 40,753,000 a year ago. Consumption of crude petroleum during September totaled 62,497,000 bbl. as against 61,041,000 in August and 62,224,000 a year ago. Stocks of crude as of Sept. 30 converted into number of days' supply, at the present rate of consumption, were sufficient for 170 days as against 180 days supply on Aug. 31 and 148 days supply on Sept. 30, 1923.

Station Piping Problems Discussed

Topics relating to piping, ranging from phosphorus to flexibility, came in for discussion at the Metropolitan Section of the American Society of Mechanical Engineers on Nov. 12. N. C. Nicol of the National Tube Co., who presented a paper dealing with the manufacture and specification of piping, questioned the advisability of limiting the phosphorus content as in standardized specifications. He suggested that the subject be investigated and if necessary that the specifications be altered in order to bring about the best results.

Webster Tallmadge, consulting engineer, discussed the field of power piping generally, including suggestions from H. LeRoy Whitney and J. O. Arkebauer, who were unable to present papers as scheduled. Steam piping, he advised, can be more economically designed by providing lower velocities and therefore less loss in pressure. This was justified in view of the decrease in both economy and capacity which it entailed.

Extreme flexibility of pipe lines, which would imply free floating on spring supports, was an essential requirement for satisfactory service.

The success of pipe joints, as developed in the discussion, appeared to depend largely on the care bestowed in erection. The familiar Van Stone joint appears equal to much more severe service than frequently given credit for, if properly erected.

Welded joints are at present subject to differences of opinion with regard to their successful operation, but it is undoubtedly recognized that the substitution of these in the place of flange joints as far as possible, will save expense and inconvenience.

Valves appear to have suffered from increase of temperature rather than pressure. Distortion is apparently responsible for most of the trouble, especially where metals which expand at a different rate from steel are utilized for the seats and are embedded in the bodies. Designs wherein these seats are carried in narrow necks above the main body and thus relieved of body distortion represent one means of solving the problem.

Carnot Centenary Celebration To Be Held Dec. 4

A centenary celebration of the announcement in 1824 by Nicholas Leonard Sadi Carnot, of the "Second Law of Thermodynamics and the Carnot Cycle," has just been announced. This law was: "In order to transform the heat of the body into work, heat must pass from that body into another at a lower temperature."

The celebration will be held in the Engineering Societies Building, 29 West 39th St., New York City, on the evening of Dec. 4, which is the last evening of the annual meeting of the A.S.M.E. The four founder societies, A.S.C.E., A.I.M.&M.E., A.S.M.E., and A.I.E.E., the Engineering Foundation, Columbia University and other scientific and educational bodies will participate. Dr. Michael Pupin will speak on "Carnot's Principle," and Dr. William Le Roy Emmett on "Application of Carnot's Principle in Engineering." William F. Durand, president elect of the A.S.M.E., will preside.

Sadi Carnot

To one man, Sadi Carnot, must go most of the credit for laying the foundations of thermodynamics, the science upon which the design of all modern heat engines is based. Carnot was born in the Luxembourg Palace, Paris, on June 1, 1796, but published his book just one hundred years ago, at the age of 28. This book, which contained material of remarkable scientific value, was lost to the world until dug up about the year 1850 by Lord Kelvin. These facts and others of interest are given in an article in the November issue of *Mechanical Engineering*. As there pointed out, some of Carnot's conclusions and predictions were truly remarkable, in view of the crude state of scientific knowledge in his day. A single quotation from his book will serve to illustrate this point:

"It is easy to see the advantages possessed by high-pressure machines over those of lower pressure. This superiority lies essentially in the power of utilizing a greater fall of caloric (heat). The steam produced under a higher pressure is found also at a higher temperature, and as, further, the temperature of condensation remains always about the same, it is evident that the fall of caloric is more considerable. But to obtain from high-pressure engines really advantageous results, it is necessary that the fall of caloric should be most profitably utilized. It is not enough that steam be produced at a high temperature; it is also necessary that, by the expansion of its volume, its temperature should become sufficiently low. A good steam engine, therefore, should not only employ steam under heavy pressure, but under successive and very variable pressures, differing greatly from one another and progressively decreasing."

The average daily production of electricity by public-utility power plants in September was 160,200,000 kw.-hr., almost 5 per cent greater than the daily output for the month of August, according to the Geological Survey.

Program for West Virginia-Kentucky Association

The West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers will hold its fourth annual convention in Huntington, W. Va., on Dec. 12-13. Papers of interest to *Power* readers which will be on the program are:

"Rotary Converters as Compared with Motor Generators," by F. M. Reigher; "Anti-Friction Bearing as Compared with Plain Type Sleeve Bearing for Mining Machinery," by N. A. Johnson; "Voltage Control in Mines by Use of Storage Batteries," by Byron B. Minnium; "Reducing Cost by Proper Supervision of Mechanical and Electrical Equipment," by J. H. Edwards; open discussion on "What Are Some of the Important Jobs Being Done by Electric Welding," and "What Is the Correct Application of Carbon Brushes for Flush and Undercut Mica Segment Commutators." Inspection will be made of industrial plants of interest.

Arizona's Election Probably Defeats Colorado Compact

With the Colorado River compact as the chief issue in the state campaign, Arizona re-elected Governor Hunt. This is believed to end all hope of ratifying the interstate treaty. While final action must be taken by the legislature, it is anticipated that that body will interpret the election as a mandate from the people and will preclude the ratification of the compact. It is probable that the Federal Power Commission will withhold action on the Colorado River projects until definitely determined that the treaty will not be established.

A new complication exists, in the Girand application for rights on the Colorado at Diamond Creek. Arizona has taken a position contrary to that of any other Western State in contending that Mr. Girand has lost his state rights by failure to continue construction work, regardless of the fact that he was forced to discontinue work by a federal injunction. While the Federal Power Commission is committed, morally at least, to grant the Girand license, it is entirely possible that the issuance of license may be delayed further pending the outcome of litigation as to the validity of his state rights.

Further engineering studies on the lower Colorado are being urged. These studies could establish more definitely than is known now the character of projects that fit best into the full development of the river. In that connection it also is being urged earnestly that immediate steps be taken to secure a treaty with Mexico to determine definitely the rights of each country in connection with the waters of the Colorado and of the Rio Grande. Treaty negotiations move slowly. Any treaty that may be drawn up is certain to provide generous treatment for Mexico. If anything is done before that treaty is ratified to increase the low water flow through the Mexican section of the river, the right of the land owners in Mexico will have been established and it may be taken for granted that none of that water will be withdrawn by treaty, once it is put to use.

Diesels for Over One-Third of Ships Under Construction

For the first time in history the tonnage of motorships begun throughout the world has exceeded the tonnage of steamships on which work was started, says E. G. Gregg, chief of the Transportation Division of the Department of Commerce, in commenting on Lloyd's Register of Shipping for the quarter ended Sept. 30, 1924 in *Commerce Reports*. Motorships on which construction was begun aggregated 261,444 gross tons, compared with a total steam tonnage of 257,660. Launchings of motorships totaled 116,336 gross tons, or 143,108 tons less than new work of this class. Motorships aggregating over 900,000 gross tons—36 per cent of the world's shipbuilding—were under construction in all countries at the close of the quarter.

The motorship in general is today the most efficient ocean transportation unit. Although a new motorship costs approximately 25 per cent more than a steamer of similar size, it can carry goods from 10 to 30 per cent cheaper.

The first small seagoing motor ship was constructed in 1910 and the first large one in 1912. Since that time motorship tonnage has increased to 1,700,000 gross tons. Of all the ships under construction in the world today more than one-third are to be equipped with Diesel engines. Heretofore only cargo boats and small passenger-cargo ships have been equipped with Diesel engines; but two passenger ships, averaging around 20,000 gross tons each are now nearly completed. Engine designs have had to be changed to develop the enormous power for driving a 20,000-ton ship at a speed of 17 knots. The double-acting type, with an impulse on each side of the piston, has been sucessfully designed and constructed. While large power installations for high speeds are not entirely faultless, it is reasonable to assume that the Diesel engine has made an entry into the most difficult marine field, the express passenger service in the North Atlantic.

Michael Fogerty Dies Suddenly

One of the outstanding figures among the practical boiler manufacturers of New York City, Michael Fogerty, died suddenly on the evening of Nov. 10. His death was a shock to his many friends, coming at the end of a usual day's work.

Mr. Fogerty was born in Fall River, Mass., in March, 1855, and was educated in the public schools of Massachusetts and Rhode Island. His early training in boiler making was obtained in the Fall River Line repair shop, where he worked from 1868 to 1874. From that time until 1877 he was employed at the Taunton Locomotive Works, at Taunton, Mass., and from 1877 to 1882 he was with the Delamater Iron Works. While at the Albany Street Iron Works in 1882, he had charge of making several Scotch-type marine boilers for Pennsylvania Railroad towboats, and later he was superintendent of the boiler shop of the West Point Foundry at Cold Spring, on the Hudson, where many types of steam boilers were manufactured. In June, 1898, he started his own business in New York City, manufacturing every shape and size of steel and iron plate boiler. He was president of the Michael Fogerty, Inc. 531 West 33d St., at the time of his death.

Among the societies with which he was connected were: The American Society of Mechanical Engineers, where his work with the Boiler Code Committee will be remembered with gratitude by his associates; the Engineer's Club, American Boiler Manufacturers' Association, Institute of Steam Boiler Inspectors of New York City and many other societies in this country and Canada. He was also an active commissioner on the Parole Board of New York. He leaves a brother and two sisters.

Water-Power Projects

Susquehanna River Project — The Susquehanna Power Co. has applied to the Federal Power Commission for a license covering its 300,000-hp. development on the Susquehanna River near Conowingo, Md. The application for a license includes as a part of the project the transmission line from Conowingo to Philadelphia.

The company proposes to erect a dam 90 ft. high and 4,400 ft. long. This will create a reservoir with a capacity of 12,500,000,000 cu. ft. The tailrace is being excavated to tidewater level. The development of this important project has been under consideration for more than sixty years. The work done by the Susquehanna Power Co. under its preliminary permit during the last two years is said to show conclusively the feasibility of this development.

Muscle Shoals—A plan is said to be afoot looking to the securing of the power to be developed at Muscle Shoals for use in Memphis, Cairo, St. Louis and intermediate points as well as for other places which would be in the region adjacent to the route of the transmission line. In this connection the suggestion has been made that it would be more to the public interest were the power from Muscle Shoals transmitted southward rather than northward. Louisiana and Mississippi are in great need of additional supplies of power. They have no hydro-electric resources within their boundaries and must draw their requirements of coal from considerable distances. There also are large areas along the South Atlantic coast, as well as the entire State of Florida, which could be served were the southeastern superpower system extended.

Skagit River Project—The City of Seattle has filed with the Federal Power Commission an application for preliminary permit covering its proposed 300,000 hp. municipal development on Skagit River. The permit states that the dam, which it is proposed to build, is to be 400 ft. high and 1,000 ft. long. At the base, however, the length of the dam will be but 50 feet. The site selected for the structure is one mile below Ruby Creek. This will create a reservoir of 1,000,000 acre-feet capacity. It is proposed further to divert Thunder Creek into the reservoir. The pressure tunnel will be 3¼ miles long. The power house will be near the mouth of Stettatle Creek. A portion of the waters of that stream also are to be used.

Society Affairs

The Milwaukee Section of the A.S.M.E will have as the subject of its Nov. 19 meeting "Diesel Engines." B. V. Nordberg, Jr., will be the speaker.

The Boston Section of the A.S.M.E. will hear Prof. L. S. Marks of the Harvard Engineering School, speak on the "Gas Turbine" at its Dec. 11 meeting.

The Los Angeles Section of the A.S.M.E. will hold its Nov. 20 dinner meeting at the Mary Louise Tea Room. C. J. Coberly, will speak on "Oxyacetylene Cutting of Metals."

The Fort Wayne, Ind., Section of the A.I.E.E. will have for its Dec. 18 meeting a paper, "Personnel Grading of Engineering Students," by Prof. A. A. Potter, School of Engineering, Purdue University. This meeting will be held at the G. E. club rooms.

The Baltimore Section, A.S.M.E. has appointed a committee to investigate the smoke problem in the city. They will co-operate with other organizations interested in smoke abatement in Baltimore in gathering and making available results of the experience of other cities where the problem has been satisfactorily solved. The next meeting of the Section, Nov. 26, will be devoted to a discussion on "What Smoke Abatement Can Do for Baltimore."

Personal Mention

Charles H. Bromley, formerly an associate editor of *Power* and for the last three years manager of the lubrication and filtration division of the S. F. Bowser & Co., Inc., Fort Wayne, Ind., has been appointed manager of the engineering sales division of that company. This is a newly created position for specialization in factory sales work. He will assume the responsibilities of his new position in connection with his former duties.

H. Foster Bain, director of the United States Bureau of Mines, E. B. Swanson, assistant to the director of the Bureau of Mines, (having been granted leaves of absence), and C. E. Williams, superintendent of the mining experiment station at Seattle, will sail from New York on Nov. 22 for Argentina at the request of the Argentine government, to make a study of the possibilities of developing an iron and steel industry in that country. The survey will include economic studies as to the feasibility of the enterprise, as well as examinations of the necessary raw materials. During the absence of the director, Dorsey A. Lyon will be acting director of the Bureau of Mines.

Business Notes

The Pittsburgh Valve Foundry & Construction Co., Pittsburgh, Pa., announces that Harold S. Hall has joined the sales department and will have charge of the new sprinkler equipment and factory heat departments.

The Jointless Fire Brick Co., Chicago, Ill., has recently established a new factory and laboratory at Trenton, N. J. for the manufacture and distribution of Philbrico, the company's product, to serve Eastern plants.

The Chicago Pneumatic Tool Co., 6 East 44th St., New York City, announces the appointment of H. E. Byer as manager of the condenser and vacuum-pump sales department, with headquarters in New York City.

The Kuhlman Electric Co., Bay City, Mich., announces: That the Globe Supply Co., 1843 Wazee St., Denver, Colo., has been appointed its representative for the territory of Wyoming, Colorado and New Mexico; Mr. Howard J. Wittman, 632 Nasby Bldg., Toledo, Ohio, will be its representative for Northwestern Ohio.

The Heine Boiler Co., St. Louis, Mo., announces that R. C. Broach, formerly in the St. Louis Sales department, has been appointed manager for its Southeastern district consisting of eastern Tennessee, North and South Carolina, Alabama, Georgia and Florida, with offices at 709 Glenn Bldg., Atlanta, Ga. S. B. Alexander, of Charlotte, N. C., will continue as special representative in North and South Carolina.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., is bringing out as an addition to its well-known Type S line, a new low-head pump. This pump will be built in the smallest sizes and will be similar to the Type S excepting that there is incorporated a number of mechanical improvements. It is also higher in efficiency due to elimination of a number of hydraulic losses.

Trade Catalogs

Boiler, Double Duty—E. Keeler Co., Williamsport, Pa. Catalog describing these boilers, which are suitable for small industrial plants using steam for processing and for heating buildings where the installation does not warrant the expense of a brick-set boiler.

Soot Blowers—Diamond Power Specialty Corp., Detroit, Mich., has just issued a new catalog, "The Best Paying Investment in the Power Plant," describing this company's valve-in-head soot blowers. It contains numerous illustrations of installations and equipment curves and other pertinent matter.

Heater, U-Tube Storage — Griscom-Russell Co., 90 West St., New York City. Bulletin 242 describes this heater, which is adapted for use in heating water in laundries, hotels, apartments and other places where the exhaust steam supply is limited. It is well illustrated and contains tables on hot-water requirements for industrial and domestic uses.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Washington, D. C. Meeting at Washington, Dec. 29-Jan. 3.

The American Boiler Manufacturers Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Midwinter meeting at Cleveland on Feb. 12.

American Ceramic Society. R. C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Columbus, Ohio, Feb. 16-21.

American Institute of Chemical Engineers. Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Hotel Schenley, Pittsburgh, Pa., Dec. 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at New York City, Feb. 9-13.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 16-19.

American Petroleum Institute. R. L. Walsh, 15 West 44th St., New York City. Annual meeting at Texas Hotel, Fort Worth, Texas, Dec. 9-11.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 22-26.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 33 West 29th St., New York City. Annual meeting at Boston, Jan. 28-30.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

Canadian Association of Stationary Engineers and Power Exposition. Miss Violet Pearce, 139 Essex Ave., Toronto, Ont. Convention at Windsor, Ont., June 23-25, 1925.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Exposition of Inventions. E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Building, 29 West 39th St., New York City, Dec. 8-13.

Illinois Society of Engineers. E. R. Tratman, Wheaton, Ill. Meeting at Chicago, Jan. 14-16.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Des Moines, Iowa, Jan. 27-30.

Kansas Engineering Society, Ernest Boyce, Lawrence, Kansas. Meeting at Lawrence, Kan., Dec. 10-12.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

National Marine Engineers Beneficial Association, Geo. A. Grubb, 313 Machinists Building, Washington, D. C. Convention at Hotel Franklin Sq., Washington, D. C., Jan. 19.

Society of Automotive Engineers. C. F. Clarkson, 29 West 39th St., New York City. Annual meeting at Detroit, Mich., Jan. 20-23.

West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers. Herbert Smith, Huntington, W. Va. Fourth annual convention at Frederick Hotel, Huntington, W. Va., Dec. 12-13.

Western Association of Electrical Inspectors. G. M. Miller, 1304 South 7th St., Louisville, Ky. Annual convention at the Brown Hotel, Louisville, Ky., Jan. 27-28.

Pipe Threading Equipment — Oster Manufacturing Co., Cleveland, Ohio. List No. 34 is a well arranged catalog covering hand and power driven machines.

Welding Electrode—General Electric Co., Schenectady, N. Y. Booklet describing this electrode gives tests, oscillograms, and instructions for using Type A welding electrode.

Flow Meters, Indicating, Recording and Registering—General Electric Co., Schenectady, N. Y. Instruction book No. 86516 gives detailed descriptions of meters, types F-12 to F-17 with flow nozzles, as well as instructions for installing and operating them.

Hoists — Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. "Floor Operated Electric Hoists," is an illustrated descriptive price list and catalog of these floor-operated hoists. Tables of dimensions, drawings and photos give definite information.

Lighting Plant, Cincinnati—The E. I. Pearson Corp., 2960 Jessamine St., Cincinnati, Ohio. Leaflet describing this small, portable, automatic lighting machine which consists of a direct-connected gas engine and generator and is specially designed for individual lighting plants.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Nov. 3, 1924	Nov. 10 1924
Pool 1	New York	$2.50@$3.00	$3.00
Smokeless	Columbus	2.15@2.35	2.25
Clearfield	Boston	1.65@2.10	2.25
Somerset	Boston	1.85@2.25	2.50
Kanawha	Columbus	1.40@1.75	1.75
Hocking	Columbus	1.50@1.70	1.70
Pittsburgh No. 8	Cleveland	1.85@1.90	1.80
Franklin, Ill.	Chicago	2.25@2.50	2.50
Central, Ill.	Chicago	2.15@2.25	2.25
Ind. 4th Vein	Chicago	2.25@2.50	2.50
West Ky.	Louisville	1.50@1.75	1.75
S. E. Ky.	Louisville	1.50@1.75	1.75
Big Seam	Birmingham	1.50@1.75	1.90

FUEL OIL

New York—Nov. 13, light oil, tank-car lots; 28@34 deg. Baumé, 4⅜c. per gal.; 36@40 deg., 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Nov. 11, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32@36 deg., gas oil, 4.776c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—Nov. 3, f.o.b. local refinery; 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.

Dallas—Nov. 5, f.o.b. local refinery, 26@30 deg., $1.20 per bbl.

Philadelphia—Nov. 11, 28@30 deg., $2.10@$2.15 per bbl.; 18@22 deg., $1.87½@$1.93¾; 13@16 deg., $1.75@$1.81½ per bbl.

Boston—Nov. 10, tank-car lots, f.o.b.; heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati—Nov. 4, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5½c. per gal.

New Plant Construction

Ala., Florence—Chamber of Commerce, L. Black, Promoter, plans the construction of a hotel, estimated cost $650,000. Architect not selected.

Ariz., Tombstone—J. L. Vermeersch, 27 South Center St., Phoenix, is preparing plans and specifications for a municipal ice and electric light plant. A bond issue will be called.

Calif., Los Angeles—Globe Ice Cream Co., 230 West Jefferson St., is having plans prepared for the construction of a 2 story ice cream plant annex on Hill St., estimated cost $150,000.

Calif., Los Angeles—F. E. Morgan, c/o Walker & Eisen, Great Republic Bldg., Archts., is preparing plans for the construction of a 13 story office and store building at 8th and Francisco Sts.

Calif., San Francisco—F. W. Leis, c/o Powers & Ahnden, 460 Montgomery St., Archts., is having plans prepared for the construction of a 12 story office and store building at Market and Fulton Sts.

Calif., Santa Barbara—The City will soon receive bids for combined pump and screen plant for sewage disposal to include one 12 in. and one 10 in. centrifugal pump direct connected to motors, one 12 in. centrifugal pump with gas engine drive, 2 cylindrical screens of 6,000,000 gal. capacity per day with sludge elecators, motors and automatic ejectors with valves, etc. H. Nunn, is city manager.

Calif., Santa Ynez—San Lucas Ranch Co., is having plans prepared for waterworks including installation of one 8 in. pump, capacity 375 cu.ft., total lift 70 ft., 150 hp. motor, cost will exceed $15,000. F. G. Walker is manager.

Fla., Moore Haven—The Bd. of Supervisors of the Diston Island Drainage Dist., C. L. Williams, Secy., will receive bids until Dec. 9 for the construction of a reclamation project, including 2 pumping plants complete with pumps, engines or motors, etc., capacity 130,000 g.p.m. each. Kirby & Myler, Moore Haven, are chief engineers.

Fla., St. Petersburg—The Vinoy Park Hotel Co., A. P. Avery, Pres., plans the construction of a hotel on Beach Drive, estimated cost $1,500,000.

La., Sterlington—The Louisiana Power Co., will build a 150 x 170 ft. gas-electric power plant. Ford, Bacon & Davis, 115 Broadway, New York, represented by G. Rhodes, resident engineer, have made plans, and will supervise construction.

Mass., Boston—Massachusetts General Hospital, Fruit St., plans the construction of a branch hospital, estimated cost $1,000,000. Architect not selected.

Mass., Springfield—H. M. Clark, Broadway, representing owner, plans the construction of a 10 story office building and garage on Worthington St., estimated cost $500,000.

Minn., Minneapolis—The city, F. S. Gram, Purch. Agt., will receive bids until Dec. 9 for the construction of a garbage incinerator, bidders to present own plans to cover structure proper, furnishing and installing equipment, including boilers, cranes, hoists, air compressors, etc. capacity 200 tons daily, estimated cost $200,000. N. W. Elsberg is engineer.

Miss., Laurel—Laurel Ice & Packing Co., is having preliminary plans prepared for an addition to ice plant, estimated cost with equipment $20,000. Ice making equipment, etc. will be required. L. W. Duffee is architect.

Mo., Columbia—Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, are preparing plans for water and electric light plant improvements.

Mo., Hollister—Empire Dist. Electric Co., H. L. Doherty, Pres., 60 Wall St., New York City, plans the construction of power dam at Table Rock, about 4 miles above here on the White River; dam to be 175 ft. high, 2,500 ft. long and will generate 32,000 hp., will form lake about 80 miles long, submerging 50,000 acres of land, upper 75 ft. of lake will be used for storage, estimated cost $30,000,000.

Mo., St. Louis—The Citizens Supervisory Committee approved plans for steam pumping equipment, etc., for the new water works system at Howard's Bend, Missouri River. E. E. Wall is water commissioner.

Mo., St. Louis — Skouras Bros. Enterprises, Grand Central Bldg., plans the construction of a 127 x 165 ft. theatre and office building at 7th and Locust Sts., estimated cost $2,300,000. E. W. Rapp & G. L. Rapp, 190 North State St., Chicago, Ill., are architects.

Mo., St. Louis—Wagner-Grant-Bell Realty Co., International Life Bldg., will build an 8 story apartment house on Skiner Road at Southwood, estimated cost $750,000. Private plans.

Mo., Sedalia—The City Water Co., has been ordered by the Missouri Public Service Comn., Jefferson City, to increase the water supply and the following improvements are contemplated. The construction of a dam and reservoir on Spring Fork, installing a 20 in. pipe line from the dam to the pumping station, raising the Flat Creek dam, installing a new pump, boiler and other accessories, estimated cost $534,000.

N. Y., Fulton—Bd. of Education, G. R. Bodley, Clk., will receive bids until Dec. 3 for furnishing oil burning equipment for the heating of 2 Ames, 125 hp. boilers in the high school here.

N. Y., New Rochelle—The Comr. of Public Works, J. A. Hadert, City Hall, will receive bids until Nov. 28 for the construction of sewage disposal works, sewage pumping station, submarine outfall, force main and connecting sewers. Contract 2, construction of machinery building, the pumping equipment provides for two 8 m.g.d. centrifugal pumping units, electrically driven and one 10 m.g.d. gasoline driven unit. Contract 3, pumping station and pumping equipment consisting of two 2 m.g.d. electrically driven centrifugal pumps, one 1 m.g.d. electrically driven centrifugal pump and one 3 m.g.d. gasoline driven centrifugal pumping unit.

N. Y., New York—M. B. Brown Printing Co., 39 Chambers St., is having plans prepared for the construction of a 15 story printing and office building at Lafayette and Duane Sts. D. M. Oltarsh, 36 West 44th St., is architect and engineer.

N. Y., New York—128 Central Park South Corp., c/o Schwartz & Gross, 347 5th Ave., Archts. and Engrs., will build a 15 story apartment house at 126-130 West 59th St., estimated cost $1,250,000. Work will be done by separate contracts under the supervision of the architects.

N. Y., New York—The Cranleigh Hospital, A. J. B. Savage, Dir. Broad St. Hospital, is having plans prepared for an 8½ story hospital including steam heating system at 159 East 19th St., estimated cost $500,000. Warren & Wetmore, 16 East 47th St., are architects.

N. Y., New York—The East 72nd Building Corp., c/o Rouse & Goldstone, 512 5th Ave., Archts. and Engrs., awarded the contract for the construction of a 15 story apartment house at 164 West 72nd St., to G. A. Fuller Co., 175 5th Ave., estimated cost $800,000. Steam heating system will be installed.

N. Y., New York—Fabian Criptal & Co., c/o Schwartz & Gross, 347 5th Ave., Archts. and Engrs. are having plans prepared for the construction of an apartment house at 37 Riverside Drive, estimated cost $1,000,000.

N. Y., New York—J. Golding, c/o Sugarman, Hess & Berger, 345 Madison Ave., Archts., plans the construction of a 15 story apartment house at 2515 Broadway, estimated cost $2,500,000. Steam heating system will be installed. Work will be done by separate contract under the supervision of architects.

N. Y., New York—A. Greenbaum & N. Wilson, c/o Polhemus & Coffin, 15 East 40th St., Archts. and Engrs., are having plans prepared for the construction of a 14 story office building at Madison Ave., and 37th St., estimated cost $2,000,000.

N. Y., New York—H. Hanlein & Sons, 417 East 103rd St., is in the market for air compressor, gasoline driven, 150 cu.ft. capacity, 100 lb. pressure.

N. Y., New York—Level Club, 922 St. Nicholas Ave., will soon receive bids for the construction of a 14 story club and hotel, including steam heating system, at 251 West 73rd St., estimated cost $1,000,000. Clinton & Russell, 100 Maiden Lane, are architects.

N. Y., New York—S. Mayer, 41 East 72nd St., awarded the contract for the construction of a 7 story apartment house on Lexington Ave., to J. H. Taylor Construction Co., 31 Union Sq., estimated cost $750,000.

Okla., Tulsa—Oklahoma Union Railway Co., 105 West 4th St., is having preliminary plans prepared for the construction of a 10 story office and railway terminal building at 4th and Cheyenne Sts., estimated cost $800,000. Hawk & Parr, Cotton Exchange, Oklahoma City, and M. B. Baldwin, Tulsa, are architects.

Ore., Baker—The Eastern Oregon Light & Power Co., have filed petition for water from the Grande Ronde River, Wallowa County, to develop 1,364 hp., estimated cost $500,000.

Pa., Meadville—Allegheny College, is receiving bids for the construction of a steam heating plant, including two 300 hp. pressure steam heating boilers, stokers, underground transmission line, etc., estimated cost $85,000. Magaziner Eberhard & Harris, 605 Chestnut St., Philadelphia, are engineers.

Pa., North Side (Pittsburgh P. O.)—Bd. of Trustees, Western State Penitentiary, will receive bids until Nov. 20 for one 800 hp. open feed water heater, 2 boiler feed water pumps, etc., in connection with the construction of the new Western State Penitentiary at Rockview.

Pa., Worthington — Graff Kittanning Clay Products Co., R. H. Graff, Gen. Mgr., is in the market for gas engine and power conveying machinery.

S. D., Redfield—The City has retained A. L. Mullergren, Consulting Engineer, Gates Bldg., Kansas City, Mo., to make a complete survey and report on its municipal light and power plant and to prepare specifications for new equipment that will be required.

Tenn., Knoxville—The City plans an election on Dec. 12 to vote a $2,500,000 bond issue for waterworks improvements, including mains, reservoir, pumping plant, etc. L. H. Brownlow is manager.

Tenn., Nashville—The City, H. E. House, Mayor, City Hall, voted $3,000,000 bonds for improvements to waterworks, including reservoir, mains, pump houses, boilers, machinery, etc.

Tex., Haskell—West Texas Utilities Co., G. Fry, Mgr., is receiving bids for the construction of an ice plant, estimated cost $45,000. Nichols & Campbell, Radford Bldg., Abilene, are architects. Owner is in the market for machinery.

Tex., Houston—San Jacinto Realty Co., is having plans prepared for the construction of a 5 story apartment house, estimated cost $500,000. G. P. Post & Son, 1003 Pioneer Trust Bldg., Kansas City, Mo., is architect.

Tex., San Antonio—W. Rogers, Travis Bldg., representing owners, having preliminary plans prepared for the construction of a 15 story office building at Commerce and Navarro Sts., estimated cost $925,000. H. S. Green, Alamo National Bank Bldg., is architect.

Wash., Port Angeles—The Elwha Power Co., has been granted a preliminary power permit by the Federal Power Comn., for a project on the Elwha River in Clallam County, for installation of 9,000 hp. The project covers a diversion dam near the mouth of Griff Creek, and a conduit 3½ miles long for delivering water to power house at the mouth of Little River.

Wis., Norwalk—Norwalk Creamery Co., F. Luetha, Secy., plans the construction of a creamery to replace plant recently destroyed by fire, estimated cost $40,000. Architect not selected. Refrigeration, cheese and butter making machinery will be required.

B. C., Vancouver—Vancouver Harbor Comrs., 525 Seymour St., is having tentative plans prepared for cold storage plant, estimated cost $500,000. G. W. Swan is engineer.

Alaska, Petersburg — The Crystal Lake Power Co., has been granted a 50 year license for a power project at Crystal Lake, which will raise the lake level six ft. and create a reservoir of 200 acres. A 5,000 ft. conduit will convey the water to a power house for generating 1,000 hp. for town lighting.